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1997

EPA Superfund
Record of Decision:

PUGET SOUND NAVAL SHIPYARD COMPLEX
EPA ID: WA2170023418
OU 04
BREMERTON, WA
12/13/1996

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DECLARATION OF THE RECORD OF DECISION

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Environmental Cleanup Office

SITE NAME AND LOCATION

Bremerton Naval Complex
Operable Unit NSC
Bremerton, Washington

STATEMENT OF BASIS AND PURPOSE

This decision document presents the selected action for Operable Unit NSC (OU NSC) at the Bremerton Naval Complex in Bremerton, Washington. This remedial action was chosen in accordance with the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA), as amended by the Superfund Amendments and Reauthorization Act of 1986 (SARA) and, to the maximum extent practicable, the National Oil and Hazardous Substances Pollution Contingency Plan (NCP). This decision is based on the administrative record for the site.

The lead agency for this decision is the United States Navy. The Washington State Department of Ecology (Ecology) and the United States Environmental Protection Agency (EPA) have participated in the scoping of the site investigations and in evaluating alternatives for remedial action. Ecology and the EPA concur with the selected remedy.

ASSESSMENT OF THE SITE

Actual or threatened releases of hazardous substances from this site, if not addressed by implementing the response action selected in this Record of Decision, may present a current or potential threat to public health, welfare, or the environment.

DESCRIPTION OF THE SELECTED REMEDY

This operable unit is one of four being evaluated at the Bremerton Naval Complex. The remedy selected for this operable unit addresses the most immediate threats for this portion of the Complex. However, the ongoing studies being conducted for Operable Unit B (OU B) include detailed investigations of groundwater throughout the Bremerton Naval Complex and the marine environment adjacent to the Complex. If the results of these investigations indicate the need for additional remedial measures for this or other operable units of the Complex, these measures will be defined in the ROD for OU B.

The selected remedy for OU NSC includes:

- Controlling access to the Bremerton Naval Complex through security measures such as fences and signs
- Establishing administrative measures to prohibit use of groundwater from the site
  Implementing deed restrictions to limit future usage of the site
- Developing a management excavation plan to limit potential contact with, and assure appropriate handling and disposal of, soils excavated during future excavation connected with any construction activity at the site
- Upgrading site paving to reduce the possibility of contact with contaminated soil and limit the potential for precipitation to transport contaminants from soil to the groundwater
- Collecting and disposing of sediments and debris accumulated in stormdrain lines serving OU NSC
- Conducting environmental monitoring to detect any change in the quality of groundwater at the site

DECLARATION

The selected remedy is protective of human health and the environment, is in compliance with federal and state requirements that are legally applicable or relevant and appropriate to the remedy action, and is cost effective. This remedy uses permanent on-site solutions and alternative treatment or resource recovery technologies to the maximum extent practicable for this site. However, because treatment of the threats at the site was found to be not practical, this remedy does not satisfy the statutory preference for treatment as a principal element of the remedy. The quantity of fill material at the site and the fact that the contaminants present occur infrequently in patterns of hot spots (due to the heterogeneous character of the fill material) make the cost of treatment excessive relative to the reduction in risk that would be achieved.

Because this remedy will result in hazadous substances remaining on site above health-based levels, long-term monitoring and institutional controls will be implemented and periodic reviews will be conducted at least every 5 years after commencement of remedial action to ensure that the remedy continues to provide adequate protection of human health and the environment.

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FIGURES

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ABBREVIATIONS AND ACRONYMS

ARAR	applicable or relevant and appropriate requirement
AWQC	ambient water quality criteria
BMP	best management practices
CCTV	closed-circuit television
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act of 1980
CFR	Code of Federal Regulations
CIA	Controlled Industrial Area
CLEAN	Comprehensive Long-Term Environmental Action Navy
COPC	chemical of potential concern
cPAH	carcinogenic polycyclic aromatic hydrocarbon
CTO	Contract Task Order
DRMO	Defense Reutilization Marketing Office
Ecology	Washington State Department of Ecology
EFA NW	Engineering Field Activity, Northwest
EPA	U.S. Environmental Protection Agency
FISC	Fleet and Industrial Supply Center
FS	feasibility study
HI	hazard index
HRA	Historical Radiological Assessment
IAG	Interagency Agreement
IRIS	Integrated Risk Information System
msl	mean sea level
MTCA	Washington State Model Toxics Control Act
MWQS	marine water quality standards
Navy	U.S. Navy
NCP	National Oil and Hazardous Substances Pollution Contingency Plan
NEESA	Naval Energy and Environmental Support Activity
NPDES	National Pollutant Discharge Elimination System
NPL	National Priorities List
NSC	Naval Supply Center
OU	operable unit
PAH	polycyclic aromatic hydrocarbon
PCB	polychlorinated biphenyl
PSNS	Puget Sound Naval Shipyard
RAB	Restoration Advisory Board
RAO	remedial action objective
RCRA	Resource Conservation and Recovery Act
RfD	reference doses
RI	remedial investigation
RI/FS	remedial investigation/ feasibility study
RME	reasonable maximum exposure
ROD	record of decision
SARA	Superfund Amendments and Reauthorization Act of 1986
SI	site inspection
SVOC	semivolatile organic compound
TAL	Target Analyte List
TCE	trichloroethene
TCL	Target Compound List
TPH	total petroleum hydrocarbons
TRC	Technical Review Committee
UBK	uptake biokinetic
URS	URS Consultants, Inc.
VOC	volatile organic compound
WAC	State of Washington Administrative Code
WTPH	Washington State Total Petroleum Hydrocarbons

DECISION SUMMARY

1.0 INTRODUCTION

In accordance with Executive Order 12580, the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA), as amended by the Superfund Amendments and Reauthorization Act of 1986 (SARA), and to the extent practicable, the National Oil and Hazardous Substances Pollution Contingency Plan, the U.S. Navy (Navy) is addressing environmental contamination at Operable Unit Naval Supply Center (OU NSC) at the Bremerton Naval Complex by undertaking remedial action. This action will be taken where necessary at OU NSC to minimize potential health risks associated with soil contamination and environmental risks associated with contaminated sediments and debris accumulated in stormdrains. The action will also reduce the potential for contaminants present in soil to reach the groundwater and Sinclair Inlet. The Navy will address petroleum contamination found at the site through a separate program. The need for additional remedial action for groundwater will be further evaluated as part of the OU B remedial investigation/ feasibility study (RI/FS). Any additional remedial measures found necessary for OU NSC during the OU B evaluation will be defined in the ROD for OU B. The U.S. Environmental Protection Agency (EPA) and Washington State Department of Ecology (Ecology) concur with the selected remedial action, which is also responsive to expressed concerns of the public. The selected remedial action will comply with federal and state applicable or relevant and appropriate requirements (ARARs).

2.0 SITE NAME, LOCATION, AND DESCRIPTION

The Bremerton Naval Complex is located in the City of Bremerton, in Kitsap County, Washington (Figure 2-1). The Complex includes two separate Navy commands: Puget Sound Naval Shipyard (PSNS) and the Fleet and Industrial Supply Center (FIS). The Bremerton Complex also includes four operable units (OUs). This Record of Decision applies to OU NSC, which coincides with FISC. When the remedial investigation (RI) process for the Bremerton Complex was being planned, FISC was known as the Naval Supply Center (NSC), and thus the name OU NSC was applied to the FISC site.

The Bremerton Naval Complex includes 354 acres of dry land: 326 acres occupied by PSNS and 28 acres occupied by FISC. Off-site railroad acreage and submerged land add approximately 1,000 acres, bringing the combined total for all lands at the Bremerton Naval Complex to 1,347 acres. Initially tidelands, the land occupied by OU NSC was created between approximately 1900 and 1950 as the Bremerton Complex expanded, by placement of miscellaneous fill materials. The ground surface throughout OU NSC is flat and almost entirely paved or covered by buildings.

FISC is bordered by Sinclair Inlet, T Street, Z Street, and Rodgers Avenue. FISC is surrounded on three sides by PSNS, but functions as a separate Navy installation, primarily in supplying materials and equipment for the Bremerton Navy Complex. FISC has a large but relatively old set of structures, including numerous buildings and a former supply pier (Figure 2-2). Because of FISC's role as a primary materials supplier to the Bremerton Complex, the buildings on site are primarily warehouses and offices for staff involved in supply functions.

A concrete quay wall reaching to an estimated depth of 40 feet below the ground surface extends along the full length of the waterfront at OU NSC. The quay wall was apparently installed in stages during the land-filling process, presumably to help control erosion of the fill by tidal action.

Until October 1996, the Defense Reutilization Marketing Office (DRMO) operated a metal scrap yard on approximately 3 acres of land within FISC property lines. DRMO was responsible for supervising and directing the disposition of surplus material from the Bremerton Naval Complex, which included storing, sorting, and arranging reuse or sale of various materials. This operation has been turned over to PSNS for operation until October 1998, at which time the scrap metal operations will end. Rail lines will continue to be used to transport materials off site for processing, although quantities of materials stored on site are expected to be well below the quantity accumulated by DRMO. As was the case when DRMO operated the facility, most of the materials processed are the result of overhaul of surface ships and recycling of submarines.

The primary oil pipelines serving the Bremerton Naval Complex run north-south beneath "W" Street in the center of OU NSC, with connections to the powerplant to the west and to storage tanks to the northeast. An oil reclaiming facility operated for many years at Building 588, in the southwest portion of the site.

Underground utilities are common throughout most of the FISC area. Sanitary sewers serving the Bremerton Complex were separated from the stormdrain system in 1975. Nine lift stations now transfer all Bremerton Complex sewage, including that from docks and piers, to the City of Bremerton Wastewater Treatment Plant. Approximately 15 stormdrains are believed to drain areas within OU NSC. The stormdrain outfalls discharge directly from OU NSC into Sinclair Inlet. Electricity, potable water, natural gas, fuel oil, steam, compressed air, and oxygen lines are also known to cross OU NSC.

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3.0 SITE HISTORY

The Bremerton Naval Complex became the region's first naval installation with the purchase of 190 acres of land in 1891. The initial area has been supplemented by additional land purchases and filling of swampy land and intertidal areas. The first drydock and associated support facilities were completed at the Complex in the spring of 1896.

Prior to World War I, barracks to house military recruits were added in the west portion of the shipyard. A drydock completed in 1919 was the largest shipbuilding drydock in the world at that time. Hemmed in by the cities of Charleston and Bremerton, the Navy faced an urgent need for additional space to support the Pacific Fleet. Between 1919 and 1921, the Navy excavated a considerable portion of the hillside nearest Sinclair Inlet, using the soil to expand the existing low-lying industrial area. World War II led to additional expansion at the shipyard, and two new piers, two more drydocks, and additional shore facilities were built.

In 1961, the Naval Complex began participating in the Navy's nuclear power program. Drydock 6, one of the world's longest drydocks, was completed during the early 1960s. Ship and submarine overhaul were major activities during the 1960s. The Naval Complex remains at the forefront of aircraft carrier design work, nuclear propulsion and repair, and numerous other specialties. It is currently the largest ship repair and overhaul facility on the West Coast. The Naval Complex currently occupies approximately 330 acres of land, which are divided between FISC (28 acres) and PSNS (302 acres).

Most of the current graded surface at OU NSC was created from fill material. The site was created through a series of fill operations approximately between 1900 and 1950. Some of this material was excavated from the natural hillside upgradient of OU NSC. The remainder is believed to have consisted of miscellaneous solid waste from shipyard operations, including excavated soils and sediments, construction debris, and spent sandblast grit. No detailed records were maintained regarding the filling activities or the materials used as fill.

When commissioned in 1967, FISC (then NSC) was assigned management responsibilities to fill the increasing need for Naval support in the Pacific Northwest. The OU NSC area has provided supply and support services for Navy activities in the Puget Sound region, throughout the Northwest, and around the Pacific Rim since the 1930s. Some of these activities involved the storage and transfer of hazardous substances. Materials historically have been stored both outdoors and indoors at OU NSC.

In the mid-1980s a long-standing sandblast grit kiln operation in the area south of DRMO ended. Sandblast grit containing paint chips from ship refurbishing had been brought in from other areas of PSNS and fed into the kilns. The paint chips, which turned to ash, were disposed of at the site either by filling around the sea wall or by dumping on the ground around the kiln. Much of the sandblast grit, however, was reportedly recovered and reused. Electrical transformers may also have been stored south of DRMO, as polychlorinated biphenyls (PCBs), a common constituent of transformer oil for many years, were found in surface soils in this area.

Since approximately 1958, the primary oil supply pipelines for the Bremerton Naval Complex have run north-south through the center of OU NSC beneath "W" Street. The pipelines and associated pumping and storage facilities have been reconfigured several times (e.g., when fuel delivery operations were moved to Pier C in 1958 and when a new power plant was brought into operation west of OU NSC in 1989). Some evidence exists that an oil pumphouse installed near the intersection of "W" Street and Wycoff Way in 1958 may have allowed oil to escape into the surrounding soil.

Following completion of the national Hazard Ranking System scoring of the shipyard in 1992, the Bremerton Naval Complex was proposed for inclusion on the National Priorities List (NPL) in the Federal Register on May 10, 1993. The Complex was listed final on the NPL effective June 1994.

Preceding the listing on the NPL, Ecology had issued Enforcement Order No. DE 92 TC-006 on March 6, 1992 requiring FISC to complete a remedial investigation/feasibility study and draft cleanup plan for the site. The Navy command responsible for completion of this work is the Engineering Field Activity Northwest (EFA NW), working in cooperation with FISC. RI/FS activities were initiated by EFA at the site in 1992 with the publication of the draft RI work plans. RI/FS activities have been ongoing at FISC since that time.

In the absence of a Federal Facilities Agreement at this site the Navy, EPA, and Ecology will negotiate an Interagency Agreement (IAG) within 180 days of the signing of this ROD. The IAG will provide the legal framework in accordance with Section 120(e) of CERCLA for the expeditious completion of the remedial activities.

The acid drain slab/pit was slated for closure through the Dangerous Waste Program in 1992. However, prior to closure it was determined to be more expeditious to remove the tank through the Toxics Cleanup Program during the removal action planned at the DRMO salvage yard. As such, the tank was transferred to the Toxics Cleanup Program for closure. The removal action satisfied the RCRA requirements for closure of the tank system.

3.1 DRMO

The scrap metal salvage yard at DRMO has been in operation approximately since the 1930s. Historical activities at DRMO that may have led to contamination include recovery of scrap metal, recycling of batteries and electrical transformers, and maintenance of vehicles.

As one of the first steps of the scrap metal recovery process at DRMO, large quantities of mixed metal scrap were routinely deposited on an unpaved area. Over many years, this practice tended to cause metal dust and metal scrap to accumulate in the soil at the stock-pile location. Routine sorting and handling of scrap metal also led to the formation of metal dusts on paved surfaces. In addition, metals with possible asbestos fittings were reported to have been buried at DRMO.

Prior to 1980, batteries recovered from trucks and other equipment at PSNS were stored at the north end of the unpaved scrap metal stockpile area at DRMO. From 1980 to 1986, batteries were recycled in a concrete-lined acid drain pit and adjacent drain slab in the battery storage area. After being washed with acid, battery components were reportedly stored on the slab and allowed to drain into the acid pit. Periodically, liquid waste consisting of rainwater and residue from battery elements was pumped out of the acid pit. The waste was then shipped off base or to the PSNS Industrial Waste Treatment Plant for treatment. The battery elements were removed and sold for recycling. Evidence of what was believed to be lead oxide dust was observed in the vicinity of the acid drain pit at DRMO in the early 1990s.

Electrical transformers were also stored southeast of the acid drain pit. The drain plugs for these transformers were reportedly removed and the liquids drained on site. Quantities of transformers and/or contaminants are unknown.

Vehicle maintenance is sometimes performed at DRMO, either in the maintenance shed in the north part of DRMO or elsewhere on site. Used motor oil is reported to have been dumped or spilled onto the ground near the maintenance shed or just south of the acid pit. Prior to 1980, drums containing used lubrication oil were stored in the northwest corner of DRMO. No visible releases were documented from these drums.

3.2 PREVIOUS INVESTIGATIONS

Numerous studies of conditions at the Bremerton Complex including OU NSC were performed before the formal remedial investigation process began in 1991. These studies included several Complex-wide investigations of potential contamination based on information regarding historical site uses; these early studies helped to prioritize later studies, including the RI. Another early complex-wide study involved an evaluation of groundwater behavior.

More localized studies have also been conducted at OU NSC. These projects have included an overall assessment of the DRMO area, studies of reported PCB contamination in surface soils south of DRMO, and an evaluation of reported oil contamination in underground electrical ducts near Building 588 south of DRMO.

The key conclusions of environmental investigations conducted at OU NSC prior to the RI were as follows:

- The pumping required to keep shipyard drydocks empty has a pronounced influence on groundwater movement in areas adjacent to the drydocks, tending to pull salt water from Sinclair Inlet inland and causing groundwater to flow towards the nearest drydock(s)

- The greatest risks to humans from contaminants at OU NSC involve surface soils at the scrap metal stockpile area and metal dusts on paving at DRMO

3.3 DRMO SOIL REMOVAL

Laboratory analyses during the 1990-91 site inspection for the Bremerton Naval Complex indicated that contaminated surface soils at the DRMO scrap metal stockpile constituted a risk to human health based on concentrations of lead and PCBs exceeding industrial screening levels. The Navy concluded that it was appropriate to eliminate this risk by performing a removal action before completing the remedial investigation.

Before conducting the removal action, the Navy distributed questionnaires and conducted telephone interviews with local officials, community residents, and public interest groups to determine the nature and type of involvement desired by the public in the overall remediation process for the Bremerton Naval Complex. The Navy used this information as a basis for preparing the Community Relations Plan/Public Participation Plan.

To support design of the removal action, additional sampling of soils and water at the stockpile were performed during 1992-93 in accordance with a set of sampling and analysis plans approved by Ecology and the EPA. An engineering evaluation/cost analysis of the proposed removal action was prepared and published on June 29, 1993. Copies of this and other documents related to the removal action were placed in the information repositories established previously at several branches of the Kitsap County Regional Library. Public notices and fact sheets were used to inform the public of opportunities to review and comment on the removal action.

Primary components of the removal action were excavating contaminated soils to a depth of approximately 4 feet, removing the acid pit and drain slab, placing an impermeable cap at the bottom of the excavated area, upgrading drainage for the stockpile area, and placing clean fill material to restore the area for use as a scrap metal stockpile. Approximately 5,000 cubic yards of soil was removed and disposed of at a landfill in Arlington, Oregon. The removal action satisfied RCRA requirements. The removal action was performed during 1994.

4.0 COMMUNITY PARTICIPATION

The Final Community Relations Plan/Public Participation Plan for the Bremerton Naval Complex is available for review at the public information repositories. In conjunction with the preparation of this plan, a Technical Review Committee (TRC) was established for the Bremerton Naval Complex. The TRC consisted of representatives of the Navy, governmental agencies, and other formal groups. To increase the opportunity for public involvement in the RI/FS process, the Navy in 1994 instituted a Restoration Advisory Board (RAB) to replace the TRC. This advisory board, which meets monthly, includes community members as well as representatives of the Navy and regulatory agencies.

The Navy periodically issues fact sheets to update the public on the status of environmental projects at the Bremerton Naval Complex. Open houses have been held approximately twice a year, providing an opportunity for the public to meet and ask questions of Navy and regulatory representatives and examine copies of the RI/FS documents. Pursuant to the public participation requirements in CERCLA the proposed plan for remedial action dated. February 1996 was mailed to interested parties in March 1996. It was also placed in the information repositories noted below and administrative record. Notice of the availability of the proposed plan and of a public meeting was published in The Bremerton Sun on March 1 and March 4, 1996. A public meeting was held in conjunction with an open house and a meeting of the Bremerton Naval Complex Restoration Advisory Board on March 5, 1996, at the Central Branch of the Kitsap County Regional Library in Bremerton. Twenty-eight people attended the meeting.

Several comments were received by the Navy concerning the proposed plan for remedial action at OU NSC. Comments were presented both orally and in writing at the public meeting and were also submitted by mail. The comments are summarized in the Responsiveness Summary (Appendix A).

The information repositories for OU NSC are located in the following branches of the Kitsap County Regional library:

Central Library	Downtown Branch Library	Port Orchard Branch Library
1301 Sylvan Way	612 5th Avenue	87 Sidney Avenue
Bremerton, Washington	Bremerton, Washington	Port Orchard, Washington
(360) 377-7601	(360) 377-3955	(360) 876-2224

This Record of Decision is based on the administrative record for OU NSC, which is located at:

Engineering Field Activity, Northwest
Naval Facility Command
19917 Seventh Avenue Northeast
Poulsbo, Washington 98370
(360) 396-0214

Arrangements to review the administrative record can be made by contacting Ms. Pam Gilmore between 9 A.M. and 11 A.M. and 1 P.M. and 4 P.M., Monday through Friday, at the phone number listed.

5.0 SCOPE AND ROLE OF OPERABLE UNIT WITHIN SITE STRATEGY

OU NSC is one of four operable units at the Bremerton Naval Complex (Figure 5- 1). The operable units (A, B, C, and NSC) were organized on the basis of Navy command structure, geographic location, site history, and suspected contamination. Separate remedial investigations are being conducted for OUs A and B at the Bremerton Complex. A proposed plan for OU A was issued on May 3, 1996. The draft RI report for OU B is scheduled to be released in the fall of 1996. Because contamination at OU C is limited to petroleum in soil and groundwater, no remedial investigation is being performed at this site. Instead, this operable unit has been the subject of a limited field investigation and pilot treatability test involving steam injection. The findings and actions undertaken at OU C will be summarized in a decision document for that site.

The soil removal action at DRMO eliminated most opportunities for direct exposure to the most contaminated soils. The selected remedy further reduces the chance of contacting site soils, limits the likelihood of contaminants being transported by infiltration to groundwater, and reduces the opportunity for chemicals to be discharged to Sinclair Inlet via the stormdrains.

Puget Sound Naval Shipyard has prepared a Historical Radiological Assessment (HRA) for the Bremerton Naval Complex to determine whether past work with radioactive materials at the Complex could present a risk to human health or the environment. Policies for preventing environmental contamination, historical records of potential releases to the environment, and results of ongoing environmental sampling were reviewed in preparation of the HRA. No evidence of any radionuclides above background levels was found by the Navy at OU NSC during this evaluation, but the EPA is still reviewing a portion of the HRA. As a matter of comity, at the request of Washington State and EPA Region 10, the shipyard will perform limited soil and groundwater sampling to confirm the conclusions of the HRA.

Currently, no remedial action is proposed specifically for OU NSC groundwater, although improvements to site paving will reduce the opportunity for chemicals to be transported from the soil to the groundwater. Site-wide groundwater modeling and a marine ecological risk assessment will be performed during the OU B RI. The site-wide groundwater model will include groundwater under OU A and OU NSC, as well as OU B. The site-wide marine ecological risk assessment will include sediments offshore of OU A and OU NSC, as well as the rest of the marine sediments. Any remedial measures found to be necessary at OU NSC as a result of the OU B evaluation will be defined in the ROD for OU B.

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Petroleum contamination at OU NSC will be addressed by the Navy under a Pacific Northwest regional program. The plans for the program will be subject to review by Ecology and the EPA. The status of the program for OU NSC will be summarized in the monitoring program for OU NSC.

6.0 SUMMARY OF SITE CHARACTERISTICS

6.1 SURFACE WATER HYDROLOGY

Because OU NSC is virtually flat, almost wholly paved, and devoid of streams and wetlands, surface water runs into stormdrain inlets and discharges via stormdrain lines directly to Sinclair Inlet. Several of the stormdrain lines serving OU NSC also receive limited inflows of surface runoff from areas adjacent to the site. The average rate of surface water discharge from OU NSC during rainfall events has been projected at 1 to 2 cubic feet per second. Virtually no flooding potential or effect from wave action exists at the site. However, many stormdrain inlets at the site appear to be at least partially blocked by accumulated sediment and debris, causing localized ponding during rainfall events.

Ecology rates Sinclair Inlet a Class A (excellent) marine water body. The Inlet is used for rearing migratory fish, commercial fish harvesting, recreational fishing and boating, and water-contact recreation.

6.2 GEOLOGY AND HYDROGEOLOGY

Prior to the establishment of the Bremerton Naval Complex, the area occupied by OU NSC consisted entirely of tidelands bordering Sinclair Inlet. The OU NSC area was developed by placing fill materials on these tidelands between approximately 1900 and 1950, as the Bremerton Complex expanded. While no specific records describing the nature of the fill materials apparently exist, it is believed that a considerable portion of the fill consisted of native soils removed from upland areas at the Bremerton Complex and other soils or sediments excavated during construction of drydocks at the Complex. Other fill materials likely included miscellaneous solid wastes resulting from the development and operation of an industrial shipyard complex. These wastes would likely have included construction debris and used grit from shipyard sandblasting operations. During the field investigations, fill materials were reported to contain both reworked materials such as asphalt, concrete, wood, brick, coal, sandblast grit, metal scraps and shavings, glass, plastic, and pipe fragments, as well as sediments, consisting of various combinations of sand, gravel, silt, clay, and shells.

A generalized geologic column through the subsurface at OU NSC, from youngest to oldest material, includes pavement, undifferentiated fill, bay mud, brown/gray sands and gravel, fine gray sands, gray clayey silt, and a till unit believed to be the Clover Park Formation Till. The thickness of the fill generally increases toward Sinclair Inlet (Figure 6-1). A different undifferentiated till believed to be the Kitsap Formation is present within the brown/gray sands in the inland areas but is absent near the shore. Figure 6-2 shows the location of several geologic cross-sections, and Figures 6-3 and 6-4 show cross-sections A-A' and B-B'.

The local groundwater flow regime at OU NSC is dominated by the pumping necessary to operate Drydock 6, located southeast of OU NSC. The drydock, which extends almost 60 feet below the ground surface, is kept empty throughout most of the year. Groundwater from the surrounding area enters the drydock through a series of weep holes designed to equalize hydrostatic pressure behind the drydock walls. Groundwater that enters the drydock, as well as saltwater seepage from Sinclair Inlet, is pumped out of the drydock and discharged to the inlet under a National Pollutant Discharge Elimination System (NPDES) discharge permit.

Potentiometric surface maps (Figures 6-5 and 6-6) developed during various tidal conditions illustrate the hydrodynamics of the local groundwater system at OU NSC. The constant pumping of water out of Drydock 6 causes a zone of depression in the surrounding water table. The zone of depression extends beneath OU NSC and is a major influence on groundwater flow direction and velocity across most of the site. Groundwater beneath OU NSC moves along flowpaths perpendicular to the potentiometric contours, resulting in a generally easterly to southeasterly flow across the site toward the northern face of Drydock 6. The drydock also tends to pull salt water from Sinclair Inlet into OU NSC and other portions of the Bremerton Complex adjacent to the drydock. However, movement of water between Sinclair Inlet and OU NSC is restricted by the presence of the concrete quay wall along the waterfront, and it is believed that the volume of water moving from the inlet across the site to the drydock may be small relative to fresh groundwater flow and salt water moving directly into the drydock through the other three walls and floor. Groundwater modeling performed by the U.S. Geological Survey indicates that the presence of the quay wall may limit water exchange between the inlet and the site to only a few percent of that which would occur if the quay wall were not present. Tidal fluctuations in Sinclair Inlet tend to have only a comparatively minor effect on groundwater levels beneath OU NSC.

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6.3 NATURE AND EXTENT OF CONTAMINATION

The remedial investigation for OU NSC included sampling and analysis of soil, groundwater, stormdrain water, and stormdrain sediments from the site. Figure 6-7 depicts the locations sampled at OU NSC.

The laboratory results reported here typically include analyses performed on samples collected during the pre-RI site inspection (SI) of 1990-91, as well as both Phase I (1993) and Phase II (1994) of the RI.

The degree of contamination was assessed by comparing analytical data to State of Washington Model Toxics, Control Act (MTCA) screening levels, water quality criteria, and, for inorganics, local PSNS-area background concentrations. Tables summarizing the investigation findings in this section typically show comparisons to the lowest of several screening levels available for each chemical. OU NSC meets the MTCA definition of an industrial site (MTCA 173-340-745): it is officially designated for industrial use, has a history of industrial use, is surrounded by industrial area, and is expected to remain in industrial use for the foreseeable future.

Ecology has developed several groups of MTCA screening levels, designated Methods A, B, and C, based on human health risk considerations. The Method A values are derived from federal Safe Drinking Water Act standards, water quality criteria, and risk assessment calculations. The Method B values are the result of risk assessment calculations based on highly conservative assumptions, for example involving a residential land use scenario, an increased cancer risk of 1 in 1,000,000, and a Hazard Index of 1. Method B typically includes the lowest numerical standards of the three methods. Method C values theoretically represent less conservative standards than Method A or B, but additional conditions must be satisfied to use Method C values. For both Methods A and C a second set of soil standards applicable to industrial sites exist. The basis for the specific standard used for screening (i.e., residential versus industrial) is noted where appropriate in the summary tables included in this section.

For inorganic analyses in soil and groundwater, results were also compared to local background values--statistically derived values representing expected naturally occurring concentrations. These background concentrations were based on samples collected in the upland portion of the Complex, where there is little chance of contamination having occurred. For water media, comparisons were also made to state and federal water quality criteria.

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6.3.1 Soil

Analytical results from samples collected from soil subsequently removed during the DRMO soil removal action are generally not included in the following presentations. However, results from samples collected from soils left in place at DRMO are included in these discussions.

A total of 318 soil samples were collected from 66 soil borings at depths ranging from the ground surface to the bottom of the sea level aquifer. Soil samples were collected and analyzed for the EPA target compound list (TCL) organic analytes, including volatile organic compounds (VOCs), semivolatile organic compounds (SVOCs), pesticides, and PCBs; for the target analyte list (TAL) inorganics (metals); and for petroleum hydrocarbons using State of Washington total petroleum hydrocarbon (WTPH) methods.

The results were screened against the lowest of the MTCA Method B or C values for soil; if no Method B or C values were available Method A values were used.

The majority of the unconsolidated materials encountered at OU NSC consist of fill materials, including both engineered backfill such as sand, gravel, and soil, and miscellaneous industrial waste. Samples were collected from both the fill and underlying native soil.

Volatile Organic Compounds

Fifty soil samples collected at various depths from 11 soil borings/monitoring wells were analyzed for 34 TCL VOCs. Thirteen VOCs were detected in soils at OU NSC (Table 6-1); however, none were detected above screening levels.

Semivolatile Organic Compounds

One hundred seventy-seven soil samples collected from 38 soil borings/monitoring wells were analyzed for 43 SVOCs. Table 6-2 summarizes the SVOCs detected at OU NSC, the frequency of detection, the minimum and maximum concentrations reported, the screening level, and the number of samples that exceeded the most stringent screening level. Thirty-one SVOCs were detected in soil at OU NSC. Concentrations of seven SVOCs exceeded the screening levels: benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, benzo(k)fluoranthene, dibenz(a,h)anthracene, chrysene, and indeno(1,2,3-cd)pyrene. All seven of these compounds are classified as carcinogenic polycyclic aromatic hydrocarbons (cPAHs). Exceedances of screening levels by these SVOCs were widespread at OU NSC. However, most of the highest concentrations were found in the southwest part of the site bounded by South Avenue and Wycoff Way at depths of 5 feet or more.

Pesticides/Aroclors (PCBs)

As shown in Table 6-3, 15 chlorinated pesticides were detected in 74 soil samples and 2 PCB congeners were detected in 176 soil samples at OU NSC. No pesticides exceeded screening levels, but both PCBs did. The PCB exceedances were found in shallow samples collected just north and south of DRMO and in subsurface soils left in place at DRMO after the soil removal.

Total Petroleum Hydrocarbons

Table 6.4 summarizes results for analysis of total petroleum hydrocarbons (TPH) in 36 soil samples. Four fractions of TPH were detected in subsurface soils at OU NSC: TPH as motor oil (TPH-motor oil), TPH as gasoline (TPH-gasoline), TPH as diesel (TPH-diesel), and TPH (total). Exceedances of screening levels occurred for all four TPH fractions. TPH exceedances of screening levels were distributed throughout OU NSC. Many of the highest observed concentrations were found adjacent to Building 467, in the rights-of-way of South Avenue, W Street, Wycoff Way, and X Street, and in the vicinity of Building 588 in the southwest corner of the site.

Inorganic Chemicals

Twenty-three inorganic analytes were detected in 174 surface and subsurface soil samples at OU NSC. Thirteen inorganics exceeded the screening levels at least once. Table 6-5 summarizes all detected inorganics, the frequency of detection, the minimum and maximum concentrations reported, the screening levels, and the number of samples that exceeded the screening levels. The inorganic analytes aluminum, calcium, magnesium, potassium, iron, and sodium are not associated with toxicity to humans under normal circumstances. Most of these chemicals are essential human nutrients, and all are either nontoxic or toxic only at very high concentrations. No screening levels are established for these inorganics. Five other inorganic analytes exceeded screening levels. Although these exceedances were distributed throughout OU NSC, many of the highest concentrations were found in three areas: DRMO and the adjacent portion of X Street, W Street south of South Avenue, and the extreme southwest corner of the site, near Buildings 588 and 210A.

6.3.2 Groundwater

The results of laboratory analyses of groundwater samples were screened against MTCA B surface water values, the National Toxics Rule for consumption of organisms, and state and federal water quality criteria. Surface water standards rather than drinking water standards were used because groundwater at OU NSC is not potable due to the influence of seawater.

Volatile Organic Compounds

Of the 19 volatile organic compounds detected in the 49 groundwater samples analyzed from 31 wells (Table 6-6), only trichloroethene (TCE) exceeded screening levels.

Semivolatile Organic Compounds

Of the 19 semivolatile organic compounds detected in 36 groundwater samples (Table 6-7), six were detected at concentrations exceeding screening levels. Most of the exceedances involved bis(2-ethylhexyl)phthalate, a common laboratory contaminant. All of the other exceedances occurred at a single location at DRMO.

Pesticides/Aroclors (PCBs)

Nineteen groundwater samples were analyzed for pesticides; 44 samples were analyzed for Aroclors. Results are summarized in Table 6-8. Eleven pesticides exceeded the screening levels. The PCB Aroclor 1260 was detected twice in groundwater above the screening level. Most of the pesticide exceedances and both of the PCB exceedances occurred at location 352 in the north central part of the site or in one of several locations at the south end of W Street.

Total Petroleum Hydrocarbons (TPR)

Thirty-four groundwater samples were analyzed for at least one of the TPH fractions. Except for TPH-gasoline, screening levels were exceeded in multiple samples, as summarized in Table 6-9. Comparatively isolated exceedances were found in the extreme northeast corner of OU NSC, just south of DRMO, and adjacent to Building 588. Exceedances at two wells each were found at the north end of X Street and at the south end of W Street. In addition to laboratory evidence of TPH dissolved in groundwater, TPH was observed floating atop the groundwater at two locations at the south end of W Street and at a third location near Building 588.

Inorganic Chemicals

Dissolved inorganic analytes detected in 44 groundwater samples from OU NSC are listed in Table 6-10. Seven inorganic analytes (arsenic, cadmium, copper, nickel, silver, thallium, and zinc) were detected above the most conservative screening value.

Table 6-11 shows concentrations of total inorganic chemicals detected in groundwater during RI Phase II. Five total inorganic analytes were detected above screening levels.

Exceedances of screening levels for inorganics are comparatively uniformly distributed across OU NSC. No pattern is evident in the distribution of total inorganics exceedances. However, the dissolved inorganics exceedances are confined to the south half of the site.

Table 6-1
Volatile Organic Compounds Detected in Soil

Chemical	Number of Samples	Number of Detections	Range of Concentrations Minimum (mg/kg)	Maximum (mg/kg)	Screening Level a and Source (mg/kg)	Number Exceeding Screening Level
Acetone	50	32	0.006	0.73	8,000 - MTCA B	0
Carbon disulfide	50	3	0.001	0.004	8,000 - MTCA B	0
Chlorobenzene	50	3	0.001	0.002	1,600 - MTCA B	0
1,1-Dichloroethane	50	1	0.008	0.008	8,000 - MTCA B	0
1,2-Dichloroethene	50	2	0.008	0.009	800 - MTCA B	0
Ethylbenzene	50	6	0.003	0.1	8,000 - MTCA B	0
Methylene chloride	50	18	0.002	0.014	133 - MTCA B	0
1,1,2,2-Tetrachloroethane	50	1	0.02	0.02	5 - MTCA B	0
Tetrachloroethene	50	9	0.003	0.17	19.6 - MTCA B	0
Toluene	50	5	0.001	0.016	16,000 - MTCA B	0
1,1,2-Trichloroethane	50	1	0.012	0.012	17.5 - MTCA B	0
Trichloroethene	50	4	0.004	0.3	90.9 - MTCA B	0
Xylenes	50	5	0.011	0.14	160,000 - MTCA B	0

a The lowest of MTCA Method B, C, or C Industrial screening levels (or MTCA A if no B or C level exists)

Note:
Table does not include results for samples collected from soil subsequently removed during DRMO soil removal.

Table 6-2
Semivolatile Organic Compounds Detected in Soil

Chemical	Number of Samples	Number of Detections	Range of Concentrations Minimum (mg/kg)	Maximum (mg/kg)	Screening Level a and Source	Number of Samples Exceeding Screening Levels
Acenaphthene	177	24	0.043	12	4,800-MTCA B	0
Acenaphthylene	177	6	0.025	0.14	-	-
Anthracene	177	34	0.015	24	24,000-MTCA B	0
Benzo(a)anthracene	177	57	0.036	39	0.137-MTCA B	36
Benzo(a)pyrene	177	53	0.036	36	0.137-MTCA B	38
Benzo(b)fluoranthene	177	61	0.019	53	0.137-MTCA B	46
Benzo(g,h,i)perylene	177	39	0.026	25	-	_
Benzo(k)fluoranthene	177	61	0.019	69	0.137-MTCA B	45
Bis(2-ethylhexyl)phthalate	177	60	0.026	0.92	71.4-MTCA B	0
Butylbenzylphthalate	177	3	0.054	0.93	16,000-MTCA B	0
Carbazole	140	13	0.042	16	50-MTCA B	0
Chrysene	177	69	0.026	36	0.137-MTCA B	41
Di-n-butylphthalate	177	5	0.03	0.056	8,000-MTCA B	0
Di-n-octylphthalate	177	16	0.51	0.48	1,600-MTCA B	0
Dibenz(a,h)anthracene	177	23	0.038	6.2	0.137-MTCA B	12
Dibeazofuran	177	17	0.028	6.9	-	_
1,2-Dichlorobenzene	120	1	0.05	0.05	7,200-MTCA B	0
1,3-Dichlorobenzene	120	1	3.1	3.1	-	_
2,4-Dimethylphenol	177	1	0.2	0.2	1,600-MTCA B	0
Fluoranthene	177	67	0.026	69	3,200-MTCA B	0
Fluorene	177	24	0.025	15	3,200-MTCA B	0
Indeno(1,2,3-cd)pyrene	177	43	0.022	23	0.137-MTCA B	31
Isophorone	177	1	1.1	1.1	1,050-MTCA B	0
2-Methylnaphthalene	177	29	0.023	17	-	_
4-Methylphenol	177	3	0.045	0.25	400-MTCA B	0
Naphthalene	177	26	0.04	23	320-MTCA B	0
4-Nitrophenol	177	1	0.055	0.055	-	0
Phenanthrene	177	63	0.027	80	-	_
Phenol	177	8	0.043	0.077	48,000-MTCA B	0
Pyrene	177	80	0.035	83	2,400-MTCA B	0
1,2.4-Trichlorobenzene	177	2	0.042	2.5	800-MTCA B	0

a The lowest of MTCA Methods B, C, or C Industrial screening levels (or MTCA A if no B or C level exists).

Notes:
Table does not include results for samples collected from soil subsequently removed during DRMO soil removal.
- No MTCA screening levels have been established.

Table 6-3
Pesticides/Aroclor Compounds Detected in Soil

Chemicals	Number of Samples	Number of Detections	Range of Concentrations Minimum (mg/kg)	Maximum (mg/kg)	Screening Level a and Source (mg/kg)	Number of Samples Exceeding Screening Levels
alpha-BHC	74	1	0.00099	0.00099	0.159-MTCA B	0
alpha-Chlordane	74	5	0.00044	0.014	0.769-MTCA B	0
Aroclor 1254	176	6	0.13	1.615	0.13-MTCA B	6
Aroclor 1260	176	18	0.008	3.165	0.13-MTCA B	7
4,4'-DDD	74	9	0.00038	0.023	4.17-MTCA B	0
4,4'-DDE	74	6	0.00029	0.0016	2.94-MTCA B	0
4,4'-DDT	74	9	0.00035	0.0093	2.94-MTCA B	0
delta-BHC	74	1	0.00017	0.00017	72.9-MTCA C Ind.	0
Dieldrin	74	4	0.00032	0.00089	0.0625-MTCA B	0
Endosulfan I	74	1	0.00047	0.00047	-	-
Endosulfan II	74	2	0.00062	0.0012	-	-
Endosulfan sulfate	74	9	0.00033	0.0023	-	-
Endrin	74	1	0.00032	0.00032	24	0
Endrin ketone	74	10	0.00042	0.047	-	-
gamma-Chlordane	74	6	0.00021	0.0031	0.769-MTCA B	0
Heptachlor epoxide	74	9	0.00026	0.003	0.11-MTCA B	0
Methoxychlor	74	2	0.00066	0.00079	400-MTCA B	0
PCB (total)	176	20	0.008	3.665	0.13-MTCA B	8

a The lowest of MTCA Method B, C, or C Industrial screening levels (or MTCA A if no B or C Level exists).

Notes:
Table does not include results for samples collected from soil subsequently removed during DRMO soil removal.
PCB Polychlorinated biphenyls
- No MTCA screening values have been established.

Table 64
Total Petroleum Hydrocarbons Detected in Soil

Chemical	Number of Samples	Number of Detections	Range of Concentrations Minimum (mg/kg)	Maximum (mg/kg)	Screening Level and Source (mg/kg)	Number of Samples Exceeding Screening Levels
TPH	23	17	32.5	20,400	200 - MTCA A	14
TPH-Diesel	36	32	14	41,000	200 - MTCA A	10
TPH-Gasoline	10	3	90	320	100 - MTCA A	2
TPH-Motor oil	29	23	29.4	12,000	200 - MTCA A	15

Note:
TPH Total petroleum hydrocarbons.

Table 6-5
Inorganic Chemicals Detected in Soil

Chemical	Number of Samples	Number of Dectections	Range of Concentrations Minimum (mg/kg)	Maximum (mg/kg)	Screening Level a and Source (mg/kg)	Number of Samples Exceeding Screening Level b
Aluminum	174	174	5,120	37,600	-	-
Antimony	161	23	0.41	853	-	-
Arsenic	174	164	0.3	31.6	1.67-MTCA B	64
Barium	174	168	6.7	2,070	5,600-MTCA B	0
Beryllium	174	73	0.17	1.2	0.233-MTCA B	67
Cadmium	174	58	0.16	26.6	80-MTCA B	0
Calcium	174	174	1,770	47,700	-	-
Chromium	174	174	2	148	80,000-MTCA B	0
Cobalt	174	172	2.2	34	-	-
Copper	163	149	1.8	11,700	2,960-MTCA B	2
Iron	174	174	7,700	49,300	-	-
Lead	174	168	0.48	18,400	250-MTCA A Res.	37
Magnesium	174	174	3,030	16,200	-	-
Manganese	174	174	111	606	11,200-MTCA B	0
Mercury	172	70	0.08	35.6	24-MTCA B	2
Nickel	174	174	11.9	461	1,600-MTCA B c	0
Potassium	174	126	96	1,940	-	-
Selenium	174	3	0.23	0.87	400-MTCA B	0
Silver	174	15	0.28	5.4	400-MTCA B	0
Sodium	174	152	144	9,080	-	-
Thallium	174	22	0.2	3.9	5.6-MTCA B c	0
Vanadium	174	171	16.7	172	560-MTCA B	0
Zinc	174	174	18.3	6,960	24,000-MTCA B	0

a The lowest of MTCA Method B, C, or C Industrial (or MTCA A if no B or C level exists).
b Only those samples that exceeded concentrations found in undisturbed shipyard soil were compared to screening level.
c MTCA screening levels are for soluble salts of nickel and thallium.

Notes:
Table does not include results for samples collected from soil subsequently removed during DRMO soil removal.
- No MTCA screening levels established

Table 6-6
Volatile Organic Compounds Detected in Groundwater

Chemical	Number of Samples	Number of Detections	Range of Concentrations Minimum (Ig/L)	Maximum (Ig/L)	Screening Level a and Source (Ig/L)	Number of Samples Exceeding Screening Level
Acetone	14	3	5	20	-	
Benzene	49	2	0.5	1	43 - MTCA B	0
Bromodichloromethane	49	1	1	1	22 - US NTR	0
2-Butanone	6	2	11	26	-	-
Carbon disulfide	49	7	0.3	17	-	-
Chloroform	49	1	23	23	283 - MTCA B	0
cis-1,2-Dichloroethene	45	18	0.3	32	-	-
Dibromochloromethane	49	1	0.9	0.9	20.6 - MTCA B	0
1,2-Dichlorobenzene	45	1	0.5	0.5	4,200 - MTCA B	0
1,1-Dichloroethane	49	8	0.6	4	-	-
1,2-Dichloroethane	49	2	2	2	59.4 - MTCA B	0
1,2-Dicbloroethene	4	3	1	10	32,800 - MTCA B	0
Ethylbenzene	49	2	0.2	1	6,910 - MTCA B	0
Tetrachloroethene	49	1	0.3	0.3	4.15 - MTCA B	0
Toluene	49	23	0.6	9	48.500 - MTCA B	0
trans-1,2-Dichloroethene	45	5	0.4	5	32,800 - MTCA B	0
Trichloroethene	49	20	0.4	58	55.6 - MTCA B	1
1,1,1-Trichloroethane	49	1	0.6	0.6	417,000 - MTCA B	0
Xylenes	49	4	1	10	-	-

a The lowest value included in the MTCA Method B surface water screening levels, the WAC 173-201A marine chronic leveLs ("WA WQC"), the federal marine chronic levels ("US WQC"), and the National Toxics Rule for consumption of organisms ("US NTR").

Note:
- No screening level established

Table 6-7
Semivolatile Organic Compounds
Detected in Groundwater

Chemical	Number of Samples	Number of Detections	Range of Concentrations Minimum (Ig/L)	Maximum (Ig/L)	Screening Level a and Source (Ig/L)	Number of Samples Exceeding Screening Level
Acenaphthene	35	3	1	1	643 - MTCA B	0
Benzo(a)anthracene	35	1	2	2	0.0296 - MTCA B	1
Benzo(a)pyrene	35	1	1	1	0.0296 - MTCA B	1
Benzo(b)fluoranthene	35	1	2	2	0.0296 - MTCA B	1
Benzo(k)fluorantbene	35	1	2	2	0.0296 - MTCA B	1
Bis(2-ethylbexyl)phthalate	36	20	1	80	3.56 - MTCA B	14
Butylbenzylphtlalate	36	1	5	5	1,250 - MTCA B	0
Carbazole	18	1	1	1	-	-
Chrysene	35	2	1	2	0.0296 - MTCA B	2
2,4-Dimethylphenol	35	1	2	2	553 - MTCA B	0
Fluoranthene	35	4	1	7	90.2 - MTCA B	0
Fluorene	35	2	1	1	3,460 - MTCA B	0
2-Methylnaphthalene	35	1	2	2	-	-
2-Methylphenol	35	1	1	1	-	-
4-Methylphenol	35	1	3	-	-	-
Naphthalene	35	5	1	11	9,880 - MTCA B	0
Phenanthrene	35	4	0.9	3	-	-
Phenol	35	3	0.5	14	1,110,000 - MTCA B	0
Pyrene	36	5	1	4	2,590 - MTCA B	0

a The lowest value included in the MTCA Method B surface water screening levels, the WAC 173-201A marine chronic levels (*WA WQC"), the federal marine chronic levels ("US WQC"), and the National Toxics Rule for consumption of organisms ("US NTR").

Note:
- No screening level established

Table 6-8
Pesticides/Aroclor Compounds Detected in Groundwater

Chemical	Number of Samples	Number of Detections	Range of Concentrations Minimum (Ig/L)	Range of Concentrations Maximum (Ig/L)	Screening Level a and Source (Ig//L)	Number of Samples Exceeding Screening Level
Aldrin	19	1	0.029	0.029	0.0000816 - MTCA B	1
alpha-BHC	19	3	0.0047	0.009	0.00791 - MTCA B	2
alpha-Chlordane	19	3	0.0017	0.0039	0.000354 - MTCA B	3
Aroclor 1260	44	2	0.27	1.1	0.000027 - MTCA B	2
4,4'-DDD	19	1	0.051	0.051	0.000504 - MTCA B	1
4,4'-DDE	19	1	0.035	0.035	0.000356 - MTCA B	1
4,4'-DDT	19	3	0.0017	0.0096	0.000356 - MTCA B	3
Endrin	19	1	0.0034	0.0034	0.0023 - US WQC	1
gamma-BHC (Lindane)	19	2	0.0019	0.054	0.0384 - MTCA B	1
gamma-Chlordane	19	3	0.0023	0.0033	0.000354 - MTCA B	3
Heptachlor	19	1	0.0012	0.0012	0.000129 - MTCA B	1
Heptachlor epoxide	19	1	0.0027	0.0027	0.0000636 - MTCA B	1

a The lowest value included in the MTCA Method B surface water screening levels, the WAC 173-201A marine chronic levels ("WA WQC"), the federal marine chronic levels ("US WQC"), and the National Toxics Rule for consumption of organisms ("US NTR").

Table 6-9
Total Petroleum Hydrocarbons Detected in Groundwater

Chemical	Number of Samples	Number of Detections	Range of Concentrations Minimum (Ig/L)	Range of Concentrations Maximum (Ig/L)	Screening Level and Source (Ig/L)	Number of Samples Exceeding Screening Level
TPH-Diesel	34	13	120	1,300	1,000 - MTCA A	2
TPH-Motor Oil	13	12	330	4,000	1,000 - MTCA A	7
TPH-Gasoline	21	8	0.5	100	1,000 - MTCA A	0
TPH	21	10	300	7,100	1,000 - MTCA A	3

6.3.3 Stormdrain Sediment

Samples of stormdrain (catch basin) sediment from four locations were analyzed during RI Phase I for SVOCs, PCBs, pesticides, TPH, and inorganics. The results were screened against MTCA values for soil and the state Sediment Management Standards applicable to terrestrial sediments. Although two of the sampled catch basins were subsequently cleaned during the DRMO soil removal, all data were included in the screening process. Nine SVOCs (Table 6-12), no pesticides, 2 PCBs (Table 6-13), 2 TPH fractions (Table 6-14), and 10 inorganic analytes (Table 6-15) exceeded the screening levels.

6.3.4 Stormdrain Water

Samples of stormdrain water from 10 locations were analyzed during RI Phase I for SVOCs, PCBs, pesticides, TPH, and total and dissolved inorganics. The results were screened against MTCA Method B values, the National Toxics Rule for ingestion of organisms, and state and federal water quality criteria. Although two sampled catch basins were subsequently cleaned during the DRMO soil removal, all data were included in the screening process. All contained detectable concentrations of SVOCs (Table 6-16). Seven SVOCs were found at concentrations exceeding screening levels. TPH was detected at all locations (Table 6-17). Five inorganic analytes exceeded screening levels in both dissolved and total fractions (Tables 6-18 and 6-19)--arsenic, copper, lead, nickel, and zinc. Two additional analytes exceeded screening values in the total fraction (Table 6-19)--cadmium and mercury (no dissolved mercury was detected).

Table 6-10
Dissolved Inorganic Chemicals Detected in Groundwater

Chemical	Number of Samples	Number of Detections	Range of Concentrations Minimum (Ig/L)	Maximum (Ig/L)	Screening Level a and Source (Ig/L)	Number of Samples Exceeding Screening Level b
Aluminum	49	10	25.2	274	-	-
Antimony	49	13	2.1	9.2	4,300 - US NTR	0
Arsenic	49	22	1.7	12.4	0.0982 - MTCA B	3
Barium	49	36	6.2	1,760	-	-
Cadmium	49	5	1.2	8.8	8 - WA WQC	1
Calcium	49	49	1,010	457,000	-	-
Chromium	49	18	0.88	40.1	162,000 - MTCA B	0
Cobalt	49	11	0.52	5.3	-	-
Copper	49	22	1	119	2.5 - WA WQC	16
Iron	49	22	57.8	16,800	-	-
Lead	49	5	1.1	2.9	5.8 - WA WQC	0
Magnesium	49	49	708	1,060,000	-	-
Manganese	49	40	2.3	9,440	-	-
Nickel	49	23	2.2	268	7.9 - WA WQC	19
Potassium	49	48	396	963,000	-	-
Silver	49	5	0.5	60.7	1.2 - WA WQC	3
Sodium	49	48	6,190	9,540,000	-	-
Thallium	49	4	3.2	3.9	1.56 - MTCA B	4
Vanadium	49	16	0.41	21.2	-	-
Zinc	49	15	8.4	79.8	76.6 - WA WQC	1

a The lowest value included in the MTCA Method B surface water screening levels, the WAC 173-201A marine chronic levels ("WA WQC"), the federal marine chronic levels ("US WQC"), and the National Toxics Rule for consumption of organisms ("US NTR").
b Only those samples that exceeded concentrations found in undisturbed shipyard locations were compared to screening level.

Notes:
- No screening level established

Table 6-11
Total Inorganic Chemicals Detected in Groundwater

Chemical	Number of Samples	Number of Detections	Range of Minimum (Ig/L)	Concentrations Maximum (Ig/L)	Screening Level a and Source (Ig/L)	Number of Samples Exceeding Screening Level b
Aluminum	49	31	213	238,000	-	-
Antimony	49	4	1	18.1	4,300 - US NTR	0
Arsenic	49	27	1.5	73.9	0.0982 - MTCA B	1
Barium	49	42	4.4	1,520	-	-
Beryllium	49	3	2	6.5	0.0793 - MTCA B	0
Cadmium	49	12	0.52	15	8 - WA WQC	0
Calcium	49	49	2,020	385,000	-	-
Chromium	49	34	1.2	426	162,000 - MTCA B	0
Cobalt	49	20	1	298	-	-
Copper	49	32	1.2	668	2.5 - WA WQC	3
Iron	49	44	7.9	290,000	-	-
Lead	49	25	2.2	2,800	5.8 WA WQC	1
Magnesium	49	49	1,490	1,030,000	-	-
Manganese	49	47	2.6	25,300	-	-
Mercury	49	15	0.21	32.2	0.025 - WA WQC	0
Nickel	49	38	1.9	1,260	7.9 - WA WQC	0
Potassium	49	47	1,270	577,000	-	-
Silver	49	4	2	51.1	1.2 - WA WQC	1
Sodium	49	49	6,040	9,920,000	-	-
Thallium	49	4	3	4.2	1.56 - MTCA B	3
Vanadium	49	32	1.1	757	-	-
Zinc	49	35	1.5	8,440	76.6 - WA WQC	0

a The lowest value included in the MTCA Method B surface water Screening levels, the WAC 173-201A marine chronic levels ("WA WQC"), the federal marine chronic levels ("US WQC"), and the National Toxics Rule for consumption of organisms ("US NTR").
b Because of high sample turbidities during the SI and RI Phase I, only RI Phase II data used in comparison. Only those samples that exceeded concentrations found in undisturbed shipyard locations were compared to screening level.

Note:
- No screening level established

Table 6-12
Semivolatile Organic Compounds
Detected in Catch Basin Sediments

Chemical	Number of Samples	Number of Detections	Range of Concentrations Minimum (mg/kg)	Maximum (mg/kg)	Screening Level a and Source (mg/kg)	Number of Samples Exceeding Screening Level
Acenaphthene	4	2	0.21	0.23	16 - SMS	0
Anthracene	4	3	0.24	0.37	220 - SMS	0
Benzo(a)anthracene	4	3	0.94	2.1	0.137 - MTCA B	3
Benzo(a)pyrene	4	3	0.58	1.1	0.137 - MTCA B	3
Benzo(b)fluoranthene	4	3	1.5	2.3	0.137 - MTCA B	3
Benzo(k)fluoranthene	4	3	0.75	1.2	0.137 - MTCA B	3
Bis(2-ethylhexyl)phalate	4	4	11	38	47 - SMS	0
Butylbenzylphthalate	4	4	1.6	130	4.9 - SMS	3
Carbazole	4	1	0.24	0.24	50 - MTCA B	0
Chrysene	4	3	1.2	2.2	0.137 - MTCA B	3
Di-a-butylphthalate	4	2	0.35	2	220 - SMS	0
Di-n-octylphthalate	4	4	1.8	7.3	58 - SMS	0
2,4-Dimethylphenol	4	1	12	12	0.029 - SMS	1
Fluoranthene	4	3	1.9	4.1	160 - SMS	0
Fluorene	4	2	0.3	0.31	23 - SMS	0
Indeno(1,2,3-cd)pyrene	4	1	0.37	0.37	0.137 - MTCA B	1
2-Methylnaphthalene	4	2	0.23	0.24	38 - SMS	0
Naphthalene	4	2	0.22	0.24	99 - SMS	0
Penanthrene	4	3	1.4	2	100 - SMS	0
Phenol	4	3	0.46	2	0.42 - SMS	3
Pyrene	4	3	1.8	4.2	1,000 - SMS	0

a The lowest of the values included in MTCA Method B, Method C, and Method C Industrial and the state Sediment Management Standards as applicable to terrestrial sediments ("SMS"). If no values exist among these standards, MTCA A values are used.

Table 6-13
Pesticides/Aroclor Compounds Detected in Catch Basin Sediments

Chemical	Number of Samples	Number of Detections	Range of Concentrations Minimum (mg/kg)	Range of Concentrations Maximum (mg/kg)	Screening Level a and Source (mg/kg)	Number of Samples Exceeding Screening Level
Aldrin	4	2	0.0018	0.002	0.0588 - MTCA B	0
alpha-BHC	4	1	0.00099	0.00099	0.159 - MTCA B	0
alpha-Chlordane	4	2	0.013	0.017	0.769 - MTCA B	0
Aroclor 1254	4	1	0.42	0.42	0.13 - MTCA B	1
Aroclor 1260	4	2	1	15	0.13 - MTCA B	2
4,4'-DDD	4	3	0.063	0.19	4.17 - MTCA B	0
4,4'-DDE	4	4	0.015	0.15	2.94 - MTCA B	0
4,4'-DDT	4	4	0.0045	0.056	2.94 - MTCA B	0
Dieldrin	4	1	0.0046	0.0046	0.0625 - MTCA B	0
Endosulfan I	4	1	0.025	0.025	480 - MTCA B	0
Endosulfan II	4	1	0.0053	0.0053	480 - MTCA B	0
Endosulfan sulfate	4	3	0.016	0.033	-	-
Endrin	4	1	0.092	0.092	24 - MTCA B	0
Endrin ketone	4	1	0.021	0.021	-	-
gamma-Chlordane	4	4	0.0044	0.023	0.769 - MTCA B	0
Heptachlor epoxide	4	1	0.0075	0.0075	0.11 - MTCA B	0

a The lowest of the values included in MTCA Method B, Method C, and Method C Industrial and the state Sediment Management Standards as applicable to terrestrial sediments ("SMS"). If no values exist among these standards, MTCA A values are used.

Note:
- No screening level established

Table 6-14
Total Petroleum Hydrocarbons Detected in Catch Basin Sediments

Chemical	Number of Samples	Number of Detections	Range of Concentrations Minimum (mg/kg)	Range of Concentrations Maximum (mg/kg)	Screening Level and Source (mg/kg)	Number of Samples Exceeding Screening Level
TPH-Diesel	4	4	940	4,100	200 - NTCA A	4
TPH-Motor Oil	4	4	8,900	41,000	200 - MTCA A	4

Table 6-15
Inorganic Chemicals Detected in Catch Basin Sediments

Chemical	Number of Samples	Number of Detections	Range of Concentrations Minimum (mg/kg)	Maximum (mg/kg)	Screening Level a and Source (mg/kg)	Number of Samples Exceeding Screening Level
Aluminum	4	4	4,160	21,000	-	-
Antimony	4	1	170	170	-	-
Arsenic	4	4	8.8	52.3	1.67 - MTCA B	4
Barium	4	4	142	2,310	5,600 - MTCA B	0
Beryllium	4	1	1.1	1.1	0.233 - MTCA B	1
Cadmium	4	3	8.9	145	5.1 - SMS	3
Calcium	4	4	9,480	20,800	-	-
Chromium	4	4	84	463	260 - SMS	1
Cobalt	4	4	9	62.3	-	-
Copper	4	4	561	39,400	390 - SMS	4
Iron	4	4	12,200	129,000	-	-
Lead	4	4	260	4,300	450 - SMS	3
Magnesium	4	4	3,760	5,770	-	-
Manganese	4	4	172	1,600	11,200 - MTCA B	0
Mercury	4	3	0.25	2.1	0.41 - SMS	1
Nickel	4	4	93.1	4,340	1,600 - MTCA B b	2
Potassium	4	1	824	824	-	-
Silver	4	1	49.2	49.2	6.1 - SMS	1
Sodium	4	4	388	730	-	-
Vanadium	4	4	23	67	560 - MTCA B	0
Zinc	4	4	715	5,680	410 - SMS	4

a The lowest of the values included in MTCA Method B, Method C, and Method C Industrial and the state Sediment Management Standards as applicable to terrestrial sediments ("SMS"). If no values exist among these standards, MTCA A values are used.
b MTCA B screening levels are for soluble salts of nickel.

Note:
- No screening level established

Table 6-16
Semivolatile Organic Compounds
Detected in Stormdrain Water

Chemical	Number of Samples	Number of Detections	Range of Concentrations Minimum (Ig/L)	Maximum (Ig/L)	Screening Level a and Source (Ig/L)	Number of Samples Exceeding Screening Level
Benzo(a)anthracene	10	1	6	6	0.0296 - MTCA B	1
Benzo(a)pyrene	10	1	5	5	0.0296 - MTCA B	1
Benzo(b)fluoranthene	10	1	8	8	0.0296 - MTCA B	1
Benzo(g,h,i)perylene	10	1	2	2	-	-
Benzo(k)fluoranthene	10	1	8	8	0.0296 - MTCA B	1
Bis(2-etbylhexyl)phthalate	10	10	1	33	3.56 - MTCA B	8
Butylbenzylphthalate	10	3	1	9	1,250 - MTCA B	0
Chrysene	10	2	1	8	0.0296 - MTCA B	2
Di-n-butylphthalate	10	2	3	5	2,910 - MTCA B	0
Di-n-octylphthalate	10	5	2	7	-	-
Diethylphthlate	10	1	1	1	28,400 - MTCA B	0
2,4-Dimethylphenol	10	2	1	2	553 - MTCA B	0
Dimethylphthalate	10	1	3	3	72,000 - MTCA B	0
Fluoranthene	10	2	2	12	90.2 - MTCA B	0
Indeno(1,2,3-cd)pyrene	10	1	2	2	0.0296 - MTCA B	1
2-Methylnaphthalene	10	1	1	1	-	-
Phenanthrene	10	2	1	3	-	-
Pyrene	10	2	2	13	2,590 - MTCA B	0

a The lowest value included in the MTCA Method B surface water screening levels, the WAC 173-201A marine chronic levels ("WA WQC"), the federal marine chronic levels ("US WQC"), and the National Toxics Rule for consumption of organisms ("US NTR").

Note:
There were no exceedances of WAC 173-201A or federal marine ambient water criteria for the protection of fish, shellfish, and wildlife.
- No screening level established

Table 6-17
Total Petroleum Hydrocarbons Detected in Stormdrain Water

Chemical	Number of Samples	Number of Detections	Range of Concentrations Minimum (Ig/L)	Maximum (Ig/L)	Number of Samples Exceeding Screening Level
TPH-Diesel	10	10	950	3,000	-
TPH-Motor Oil	10	10	1,200	15,000	-

Note: - No screening level established

Table 6-18
Dissolved Inorganic Chemicals Detected in Stormdrain Water

Chemical	Number of Samples	Number of Detections	Range of Concentrations Minimum (Ig/L)	Maximum (Ig/L)	Screening Level a and Source (Ig/L)	Number of Samples Exceeding Screening Level
Aluminum	10	6	33.2	559	-	-
Antimony	10	1	29.4	29.4	4,300 - US NTR	0
Arsenic	10	3	2.3	2.9	0.0982 - MTCA B	3
Barium	10	2	38.7	46	-	-
Cadmium	10	6	0.63	3.8	8 - WA WQC	0
Calcium	10	10	2,240	32,500	-	-
Copper	10	9	18.6	338	2.5 - WA WQC	9
Iron	10	10	160	465	-	-
Lead	10	10	2	64.6	5.8 - WA WQC	5
Magnesium	10	10	311	7,410	-	-
Manganese	10	10	17.4	153	-	-
Nickel	10	2	22.8	69.5	7.9 - WA WQC	2
Potassium	10	3	886	4,810	-	-
Sodium	10	10	1,120	20,500	-	-
Zinc	10	10	43.3	628	76.6 - WA WQC	7

a The lowest value included in the MTCA Method B surface water screening levels, the WAC 173-201A marine chronic levels ("WA WQC"), the federal marine chronic levels ("US WQC"), and the National Toxics Rule for consumption of organisms ("US NTR").

Note: - No screening level established

Table 6-19
Total Inorganic Chemicals Detected in Stormdrain Water

Chemical	Number of Samples	Number of Detections	Range of Concentrations Minimum (Ig/L)	Range of Concentrations Maximum (Ig/L)	Screening Level a and Source (Ig/L)	Number of Samples Exceeding Screening Level
Aluminum	10	10	502	8,280	-	-
Antimony	10	3	7.4	45.8	4,300 - US NTR	0
Arsenic	10	9	2	9.8	0.0982 - MTCA B	9
Barium	10	9	21.1	157	-	-
Cadmium	10	10	0.61	17	8 - WA WQC	3
Calcium	10	10	3,380	39,700	-	-
Chromium	10	6	12.1	87.8	162,000 - MTCA B	0
Cobalt	10	2	10	11.4	-	-
Copper	10	10	37.4	1,160	2.5 - WA WQC	10
Iron	10	10	859	15,900	-	-
Lead	10	10	19	503	5.8 - WA WQC	10
Magnesium	10	10	491	9,130	-	-
Manganese	10	10	31.4	222	-	-
Mercury	10	2	0.23	0.38	0.025 - WA WQC	2
Nickel	10	9	20.8	150	7.9 - WA WQC	9
Potassium	10	4	1,160	4,790	-	-
Sodium	10	10	1,370	21,400	-	-
Vanadium	10	2	12.3	27.4	-	-
Zinc	10	10	110	825	76.6 - WA WQC	10

a The lowest value included in the MTCA Method B surface water screening levels, the WAC 173-201A marine chronic levels ("WA WQC"), the federal marine chronic levels ("US WQC"), and the National Toxics Rule for consumption of organisms ("US NTR").

Note:
- No screening level established

7.0 SUMMARY OF SITE RISKS

7.1 HUMAN HEALTH RISK ASSESSMENT

The human health risk assessment process is used to estimate the probabilities of adverse health effects from hypothetical current and future exposures to chemicals of concern in the absence of remediation. The risk assessment is a multistep process that involves data evaluation, chemical toxicity assessment, and exposure assessment. The information gathered during each of these three steps is combined to quantify noncancer and cancer risks in a final step-risk characterization.

Data evaluation includes screening detected chemicals according to EPA guidelines to identify chemicals of potential concern (COPCs) for further evaluation. Inorganic chemicals whose maximum detected concentrations are less than the calculated background concentrations are eliminated from the risk assessment during this screening process. Toxicity information for the COPCs identified during the screening process, obtained from the EPA's Integrated Risk Information System (IRIS) database, are used in performing a chemical toxicity assessment. EPA default exposure parameters, together with site-specific exposure assumptions, are then applied in performing a detailed exposure assessment, evaluating specific exposure settings and pathways.

Noncancer risks are quantified by comparing the estimated intake dose resulting from site exposure to a reference dose (RfD), an EPA estimate of the acceptable daily intake of a chemical. Noncancer risk is expressed in the form of a hazard index (HI). HI values less than 1.0 are not considered a concern.

Cancer risks are expressed as an excess probability that an individual will develop cancer if exposed to a chemical over a lifetime. For example, a risk expressed as 1.0 x 10 -6 means that 1 out of 1,000,000 exposed people may develop cancer over a lifetime of exposure to the specified chemicals at the site. The National Oil and Hazardous Substances Pollution Contingency Plan (NCP) states that acceptable values for cancer risk lie between 1 x 10 -4 and 1 x 10 -6. MTCA requires that the maximum site incremental cancer risk not exceed 1 in 100,000. None of the current or expected site risks exceed that level.

Soils are the primary contaminated medium at OU NSC to which humans are likely to be exposed. The site is almost completely paved, so there is only limited potential for chemicals to become airborne. Groundwater at the site is not potable because of the influence of seawater. Materials within the stormdrain system are not accessible. Consequently the selection of COPCs for OU NSC focused primarily on soil samples. The identified COPCs are summarized in Table 7-1.

Table 7-1
Chemicals of Potential Concern at OU NSC

Inorganics	
Antimony	Chromium
Arsenic	Copper
Barium	Lead
Beryllium	Mercury
Cadmium	Thallium
Semivolatile Organic Compounds	
Benzo(a)anthracene	Carbazole
Benzo(a)pyrene	Chrysene
Benzo(b)fluoranthene	Dibenz(a,h)anthracene
Benzo(k)fluoranthene	Indeno(1,2,3-cd)pyrene
Chlorinated Pesticides/PCBs	
Aroclor 1254	alpha-BHC a
Aroclor 1260	delta-BHC a
Petroleum Hydrocarbons	
TPH-Diesel a	TPH-Motor Oil a
TPH-Gasoline a	

a Listed as a COPC because no approved toxicity values are available.

Note:
TPH Total petroleum hydrocarbons

For OU NSC four exposure scenarios were evaluated: a current utility worker, a future construction worker, a future industrial worker, and a future resident. The first three represent the most likely scenarios for current and future exposure to site chemicals, since the shipyard is an essential Navy facility and is likely to remain in industrial use indefinitely. The fourth scenario, representing the highly unlikely possibility of future residential use of the site, is routinely included in the risk assessment process at the request of the EPA.

Cancer and noncancer risks were evaluated for each of the four scenarios for three significant pathways of exposure: ingestion of soil, skin (dermal) contact with soil, and inhalation of airborne soil particles. Both average and reasonable maximum exposure (RME) chemical concentrations were evaluated. The RME concentration represents the highest concentration to which a person is likely to be exposed at the site. For this risk assessment the lower of the 95th percentile upper confidence level estimate of the mean or the maximum detected concentration was used for the RME value.

EPA default exposure values were augmented with several site-specific assumptions based on interviews with shipyard personnel regarding typical site operations. Examples include:

- In calculating soil ingestion rate and exposure to airborne chemicals it was assumed that 30 percent of a utility worker's time is spent in direct contact with soil.

- In calculating exposure frequency, 50 percent of a shipyard utility worker's time was assumed to be spent actually performing utility repairs.

- Twenty-five percent of the repairs performed by a utility worker were assumed to be performed at OU NSC for the RME case and 10 percent were assumed for the average case.

- For the average industrial worker scenario an exposure duration of 10 years, the average shipyard length of employment at one location was assumed.

- For construction workers exposure durations of 6 months and 4 months were assumed for the RME and average case, respectively.

Because the laboratory methods for total petroleum hydrocarbons cover a broad range of chemicals rather than single chemicals, the results of these analyses tend to have a comparatively high degree of uncertainty associated with them. Consequently the primary toxic chemicals potentially found in TPH mixtures, listed as semivolatile organic compounds in Table 7-1, were used in the risk assessment instead of TPH. Provisional toxicity values were also used to perform limited separate evaluations of the risks associated with contact with TPH fractions in soil for several of the scenarios to augment the formal risk assessment. These evaluations, summarized in the final OU NSC RI report, demonstrated:

- Potential noncancer risks to current utility workers and future industrial workers from diesel are below levels of concern.

- Potential cancer risks to future industrial workers from gasoline are below levels of concern.

- Potential cancer risks to future residents from gasoline are below levels of concern.

- However, potential noncancer risks to future residents from diesel are a concern.

Information essential in performing the risk assessment process, typically identified and published by the EPA is incomplete for lead. Consequently lead could not be included in the primary risk assessment. However, the RME concentration of lead in soil exceeds the MTCA Method C Industrial standard; consequently lead is believed to present a potential risk to present and future site workers. An evaluation of potential lead uptake from contact with soil also demonstrated that soil lead levels at OU NSC would constitute a potential risk to children if the site were to be converted to residential use in the future.

The incremental noncancer risks predicted for the four exposure scenarios using the three pathways and two concentration alternatives, together with the total predicted noncancer risks, are summarized in Table 7-2. The predicted cancer risks are summarized in Table 7-3.

The overall conclusion of the baseline human health risk assessment is that both noncancer and cancer risks to current utility workers and future construction workers are below levels of concern. However, when TPH is taken into consideration, site soils do pose unacceptable risks to future residents at OU NSC. The effect of lead cannot be included in the risk calculations. However, lead levels in soil are believed to pose a health risk to site workers and any future residents.

Table 7-2
Summary of Total Noncancer Risks for OU NSC

Case	Ingestion of Chemicals From Soil	Inhalation of Airborne Chemicals	Dermal Contact With Chemicals in Soil	Total Noncarcinogenic Risk
RME Case				
Current Utility Worker a	<0.01	<0.01	<0.01	<0.01
Future Construction Worker a	0.046	<0.01	0.019	0.06
Future Industrial Worker b	0.05	<0.01	0.08	0.1
Future Resident c	0.4	<0.01	0.1	0.5
Average Case				
Current Utility Worker a	<0.01	<0.01	<0.01	<0.01
Future Construction Worker a	0.035	<0.01	<0.01	0.04
Future Industrial Worker b	0.01	<0.01	0.04	0.05
Future Resident c	0.08	<0.01	0.02	0.1

a Risks were calculated using OU NSC-specific exposure parameters.
b Risks were calculated using the EPA default exposure parameters for an industrial worker.
c Risks were calculated using the EPA default exposure parameters for a resident.

7.2 ECOLOGICAL RISK ASSESSMENT

7.2.1 Terrestrial Ecological Risks

Since OU NSC is almost completely paved and no vegetation exists at the site, no terrestrial ecological risk assessment was performed. Because of the lack of terrestrial receptors, ecological risk at the site is insignificant.

7.2.2 Marine Ecological Risks

Potential ecological risks to marine biota due to chemicals at the entire Bremerton Complex including OU NSC are being assessed as part of the RI/FS currently being performed for OU B. Information regarding the marine environment adjacent to OU NSC collected during the site inspection is reported in a hydrogeological and biological investigation report. Preliminary results and findings from the Phase I marine investigations for OU B are included in the OU B Phase I Technical Memorandum. The results of the OU B marine investigation may indicate the need to evaluate the groundwater-to-Inlet pathway throughout the Naval Complex.

Table 7-3
Summary of Total Cancer Risks for OU NSC

Case	Ingestion of Chemicals From Soil	Inhalation of Airborne Chemicals	Dermal Contact With Chemical in Soil	Total Carcinogenic Risk	Primary Causes of Risk
RME Case					
Current Utility Worker a	2.6E-07	1.8E-09	4.7E-07	7E-07	As, PCBs
Future Construction Worker a	1.5E-07	7.7E-10	6.2E-08	2E-07	As, PAHs
Future Industrial Worker b	7.7E-06	2.3E-08	3.1E-06	1E-05	As, PAHs
Future Resident c	6.9E-05	3.8E-08	1.6E-05	9E-05	As, FAHs
Average Case					
Current Utility Worker a	2.6E-08	1.2E-10	3E-08	6E-08	As, PCBs, PAHs
Future Construction Worker a	6.03E-08	2.4E-10	1.7E-08	8.08E-08	As, PAHs
Future Industrial b Worker	2.1E-06	8E-09	5.7E-07	3E-06	As, PAHs
Future Resident c	4.2E-06	7.7E-09	7.9E-07	5E-06	As, PAHs

a Risks were calculated using OU NSC-specific exposure parameters.
b Risks were calculated using the EPA default exposure parameters for an industrial worker.
c Risks were calculated using the EPA default exposure parameters for a resident.

Notes:
As Arsenic
PAH Polycyclic aromatic hydrocarbon
PCB Polychlorinated biphenyl

7.3 UNCERTAINTY ANALYSIS

The uncertainty analysis for the OU NSC baseline risk assessment summarizes the assumptions and limitations inherent in each step of the risk assessment process and their effects on the overall risks calculated for the site.

7.3.1 Data Evaluation

Laboratory results from site samples were compared with results of analysis of sample blanks in order to exclude chemicals from the risk assessment that were most likely artifacts of the sampling or analytical processes. This procedure may have resulted in inclusion of some artifacts and exclusion of some chemicals actually present on site.

Choices made regarding the use of qualified data in the risk assessment, such as eliminating rejected data or including estimated data, may have resulted in underestimation or overestimation of risks.

Moderate uncertainty was introduced into the risk assessment process because the laboratory detection limits for a few chemicals were higher than the RBSCs used for making screening comparisons. Although detection limits exceeded RBSCs for several inorganics, two Aroclors, and several organic compounds, only in the case of several polycyclic aromatic hydrocarbons was significant uncertainty introduced.

The exclusion of compounds that could not be explicitly identified by the laboratories ("tentatively identified compounds") could have caused an underestimation of risks.

Chemicals that were infrequently detected may be artifacts in the data caused by sample contamination, lab errors, or other problems, rather than site-related chemicals. Inclusion of infrequently detected analytes as COPCs may have led to an overestimation of risk.

7.3.2 Toxicity Assessment

Several uncertainties associated with the toxicity assessment are described in the final RI report. Several of the most important of these are summarized below.

Various degrees of uncertainty are associated with the classification of chemicals as human carcinogens. The least uncertainty is associated with chemicals known to cause cancer in humans and the greatest uncertainty is associated with chemicals where there is no evidence of human carcinogenicity and only limited evidence of carcinogenicity in animals.

The assumption that carcinogenic response is linear with respect to dose and that there is no threshold value for inducing cancer introduces several uncertainties. Current theories suggest that carcinogens may act by several different mechanisms, which could result in more than one type of dose-response curve. However, data are inadequate to support more detailed assumptions regarding dose response.

A large range in the uncertainty factor is involved in deriving specific reference dose values for use in evaluating the noncancer risk of individual chemicals. This indicates very high uncertainty regarding the actual values of the RfDs for these chemicals, which can result in the prediction of risk where none may exist.

Since toxicity data were not available for lead or TPH, these chemicals were not included in the risk assessment. Because risks could not be fully quantified for these chemicals, total site risks may have been underestimated.

There is moderate to high uncertainty regarding the methodology and absorption rates used in evaluating skin (dermal) contact with chemicals.

7.3.3 Exposure Assessment

Areas of uncertainty associated with the exposure assessment include identification of exposure receptors and pathways, calculation of exposure point concentrations and intakes, and selection of exposure parameters.

Exposure pathways were conservatively selected, based on exposure media, activities known or expected to occur, and importance relative to other pathways. A number of uncertainties are associated with the exposure parameters used for each scenario evaluated. Most exposure parameters used in the RME scenario are conservative, and likely result in highly conservative risk calculations. Parameters for the average scenario are more representative of typical exposures.

Some uncertainty is introduced through including results that are below detection limits in exposure point concentration calculations, typically by using a value equal to one-half the detection limit. If unusually high sample quantitation limits are reported, the degree of this uncertainty is escalated, resulting in skewed statistical parameters and overestimates of risk.

Potential risks resulting from exposures to marine media were not evaluated as part of this risk assessment. Because the future residential scenario did not include consideration of fish and shellfish ingestion, the total future residential risk may be underestimated. Exposures to chemicals potentially present in the marine environment will be addressed during the RI for OU B.

7.3.4 Risk Characterization

The reasonable maximum exposure scenario was designed to represent the upper bound of probable exposure and thus is intentionally conservative. Consequently, the RME risk evaluations likely overestimate the risks. The results of the evaluation of average exposure concentrations are more realistic, but still likely represent conservative risk estimates.

Several potential uncertainties are associated with the assumption that the risks due to exposure to multiple chemicals are equal to the sum of the risks calculated for the individual chemicals. Collectively, these uncertainties could lead to either underestimation or overestimation of risk.

Several assumptions inherent in the evaluation of carcinogenic risks tend to cause cancer risks to be overestimated.

In summary, there is a low probability that the reported risks at OU NSC are an underestimate and a high probability that the reported risks are an overestimate.

8.0 REMEDIAL ACTION OBJECTIVES

Remedial action objectives (RAOs) consist of medium-specific or operable unit-specific goals for protecting human health and the environment. The objectives should be as specific as possible, but not so specific that the range of alternatives that can be developed is unduly limited. RAOs were developed for OU NSC for those chemicals of concern identified by comparing laboratory results to chemical-specific regulations and as a result of the baseline risk assessment. The regulations addressed in the RI report include MTCA cleanup levels that focus on water quality standards and on human exposure via direct contact or via ingestion of soil, groundwater, or marine life.

Land use at OU NSC is expected to remain industrial in the future based on the important role of the Bremerton Naval Complex. The RAOs for soil were developed on this basis for human ingestion and contact. RAOs for soil for protection of adjacent surface water will be developed as part of the OU B ROD if appropriate.

The general conclusion of the baseline risk assessment is that the predicted cancer and noncancer risks posed by chemicals at OU NSC are below or within established acceptable ranges. However, lead concentrations observed in soil, but not included in the calculated risks, present a health risk to site workers and hypothetical future residents.

8.1 GROUNDWATER

Much of the groundwater beneath OU NSC is not suitable for use as drinking water because seawater intrusion makes it too salty. Therefore, cleaning up the groundwater to drinking water standards is not an objective. However, preventing accidental contact with groundwater is an objective.

Although groundwater is not of concern related to human use, it may represent a pathway for migration of contaminants to the marine environment (Sinclair Net). Most of the groundwater beneath OU NSC flows toward Drydock 6 as a result of the nearly constant drydock dewatering operation. Groundwater seeps through weep holes in Dryclock 6 and combines with other flows into the drydock, and the sum of these flows is released into Sinclair Inlet. When Drydock 6 is not being dewatered, the natural flow of OU NSC groundwater is toward Sinclair Inlet. Also, at low tides some of the groundwater at the site discharges directly to Sinclair Inlet, rather than via Drydock 6. By whatever pathway, the movement of groundwater from OU NSC to Sinclair Inlet has the potential to transport dissolved chemicals to the marine environment. Thus, it is possible that the OU NSC contaminants could contribute to adverse effects in marine life in the Inlet. To evaluate the potential for adverse marine effects, the concentrations of chemicals in groundwater and Drydock 6 seeps were (1) compared to surface water quality criteria and (2) modeled to determine the fate and transport of chemicals of concern from groundwater to Sinclair Inlet.

Chemicals that frequently exceeded surface water quality criteria in groundwater collected from OU NSC included TPH, copper, and nickel. Pesticides (alpha- and gamma-chlordane, 4,4'-DDT, etc.), PCBs, arsenic, and silver exceeded surface water criteria at less than 10 percent of the groundwater sampling locations. Samples of seep water entering the northwest end of Drydock 6 contained arsenic and lead in exceedance of surface water standards. The detection limits for pesticides and PCBs in the northwestern Drydock 6 seep samples exceeded the surface water criteria. Therefore, it is uncertain, based on these tests, whether pesticides and PCBs exist at levels of concern. However, since both pesticides and PCBs were detected in OU NSC groundwater and other-drydock samples, these chemicals remain of concern.

The fate and transport modeling of chemicals in the OU NSC groundwater indicated that, under present site conditions, the mass flux of contaminants in groundwater discharging into the marine water does not appear to significantly affect ambient concentrations in Sinclair Inlet. This is because OU NSC groundwater is diluted with Sinclair Inlet water and other groundwater as it enters Drydock 6. This indicates that OU NSC groundwater probably does not represent a significant risk to the marine environment. Because of some uncertainties associated with the modeling and the need to evaluate groundwater at the naval complex as a whole (since there are no geographical boundaries between OU NSC and OU B), the groundwater to surface water pathway will be further evaluated for the entire complex as part of the OU B RI/FS groundwater modeling and ecological risk assessment.

Because groundwater contamination does not appear to present an unacceptable risk to humans (since it is not potable) or the environment (modeling showed rapid dilution with Sinclair Inlet water prior to discharge), active remedial measures (e.g., collection and treatment, containment) were not selected under this ROD. However, those chemicals that frequently exceeded surface water standards in groundwater and have been identified as discharging to Sinclair Inlet at levels exceeding surface water standards in seeps should be monitored to ensure that the conclusion that the site presents low risk continues to be justified. Also, groundwater impacts should be considered where remedies are selected for other media. Therefore, the RAO established for groundwater is to reduce the potential for arsenic, copper, nickel, lead, pesticides, PCBs, and TPH to reach the groundwater, to the extent feasible using technologies that are implementable and effective for the site. The remediation goals for these chemicals are shown in Table 8-1.

If additional remedial measures are determined to be necessary for OU NSC groundwater as a result of the OU B modeling and ecological risk assessment, these measures will be defined in the ROD for OU B.

8.2 SOILS

The chemicals in soils at OU NSC for which remedial actions were considered are carcinogenic polycyclic aromatic hydrocarbons, PCBs, lead, and total petroleum hydrocarbons. These chemicals were selected based on exceedances of industrial standards and, in the case of lead and TPH, potential risk to future residents or site workers.

In general, the highest concentrations of cPAHs were found at depths great enough to avoid a health risk under present site uses. Polycyclic aromatic hydrocarbons (PAHs) may have been present in the fill material used to develop the site; they could also be connected with petroleum contamination.

The highest lead concentrations measured at OU NSC were found in the vicinity of the DRMO. This lead is believed to have resulted from battery storage and recycling activities in this area. Soil removed from the unpaved area at DRMO during the interim soil removal action included soil associated with several of the highest lead concentrations. However, elevated lead levels were also measured in the soil left in place below the excavation. Lead is also believed to have been present in the fill material used to develop OU NSC, and lead is comparatively common in soils throughout much of the site.

TPH is also pervasive at OU NSC. Many of the highest measured concentrations were found in the area east and north of Building 467, largely coinciding with the primary Bremerton Complex fuel oil supply lines and associated pump and storage facilities. High TPH concentrations were also reported from the vicinity of the oil-water separator at Building 588, in the southwest comer of OU NSC.

The RAO for soil is to reduce human exposure to the chemicals of concern and to reduce or control contamination of groundwater. The risk assessment demonstrated that potential inhalation of soil particles is a comparatively minor source of risk. The soil exposure pathways to be controlled are direct contact with and ingestion of soil. Based on the results of the risk assessment and comparison to MTCA industrial standards, the chemicals of concern in the soil are lead, cPAHs, PCBs, and TPH. The remediation goals for these chemicals are shown in Table 8-2.

Table 8-1
Groundwater Cleanup Levels for OU NSC

Parameter	CAS #	Regulatory Level (Ig/L)	Basis	Practical Quantitation Limit (Ig/L)	Cleanup Level a (Ig/L)
Arsenic	7440-38-2	0.0982	MTCA B	0.5	0.5
Copper	7440-50-8	2.5	State WQC	2.5	2.5
Lead	7439-92-1	5.8	State WQC	5	5.8
Nickel	7440-02-0	7.9	State WQC	5	7.9
alpha-BHC	319-84-6	0.00791	MTCA B	0.01	0.01
alpha-Chlordane	57-74-9	0.000354	MTCA B	0.01	0.01
4,4'-DDT	50-29-3	0.000356	MTCA B	0.02	0.02
gamma-Chlordane	57-74-9	0.000354	MTCA B	0.01	0.01
Total PCBs	1336-36-3	0.000027	MTCA B	0.2	0.2
Total Petroleum Hydrocarbons	-	1,000	MTCA A	250	1,000

a Cleanup level established as the higher of the regulatory level or the PQL; see WAC 173-340-700(6) and Ecology Implementation Memo #3 of November 24, 1993

Notes:
Based on protection of adjacent surface waters of Sinclair Inlet
- No CAS # available

Table 8-2
Soil Cleanup Levels for OU NSC

Parameter	CAS #	Regulatory Level (mg/kg)	Basis	Practical Quantitation Limit (mg/kg)	Cleanup Level (mg/kg)
Lead	7439-92-1	1,000	MTCA A Industrial	5	1,000
Individual cPAHs	56-55-3; 50-32-8; 205-99-2; 207-08-9; 218-01-9; 53-70-3; and 193-39-5	18	MTCA C Industrial	1	18
Total PCBs	1336-36-3	17	MTCA C Industrial	0.1	17
Total Petroleum Hydrocarbons	-	200	MTCA A	25	200

Notes:
Based on industrial site usage; soil cleanup levels based on protection of adjacent surface waters of Sinclair Inlet will be defined, if appropriate, in the ROD for Operable Unit B

- No CAS # available

8.3 SURFACE WATER

Several chemicals of concern for surface water were identified by comparing analytical results for samples collected from the stormdrains with MTCA surface water cleanup levels. The primary chemicals of concern were inorganics, including arsenic, copper, lead, nickel, and zinc. The likely source of these chemicals is the debris accumulated in the stormdrains. Discharges from stormdrains represent a direct impact to Sinclair Inlet. Therefore, the RAO for surface water is to reduce the potential for chemicals of concern to be introduced into water flowing through the stormdrains and thus discharged to Sinclair Inlet. Numerical remedial goals were not developed for stormdrains because methods used to remove potentially contaminated materials would not allow cost-effective differentiation between contaminated and uncontaminated materials.

8.4 STORMDRAIN SEDIMENTS

Several chemicals of concern were identified for stormdrain sediments by comparing analytical results for samples collected from the stormdrains with MTCA soil standards and the state Sediment Management Standards applicable to terrestrial sediments. The primary chemicals of concern included PAHs, PCBs, and inorganics, including arsenic, cadmium, copper, lead, and zinc. These chemicals are associated with sediment soil and debris that have washed into the stormdrain system and accumulated over many years. The RAO for stormdrain sediments is to reduce the potential for chemicals of concern to be discharged to Sinclair Inlet. As noted above, numerical remedial goals were not developed for stormdrain media.

9.0 DESCRIPTION OF ALTERNATIVES

Seven remedial alternatives for OU NSC were developed for screening purposes. Each of the alternatives includes monitoring. In Alternative 1, No Action, the monitoring would provide only the data necessary to complete a 5-year review of the site as required under CERCLA. The remaining alternatives would include monitoring of groundwater.

Alternative 1, No Action, is required to be considered under CERCLA. Alternative 2 relies on institutional controls. Alternative 3 adds upgrading of the existing cap (i.e., pavement), a plan to minimize exposure of soil during future excavation, and cleaning of stormdrains. To Alternative 3, Alternatives 4 through 7 add treatment for both soil and groundwater, differing in whether treatment is in situ or otherwise.

Several considerations were especially important in evaluating the alternatives. Excavation of soil (except shallow soil) is not feasible in most of the eastern two-thirds of OU NSC because of the presence of many buildings, numerous underground utilities, and heavy vehicle and pedestrian traffic. Yet the eastern two-thirds of the site is where much of the TPH and PAH contamination is located, largely at depths greater than 5 feet. For this reason, the alternatives involving active soil remediation (Alternatives 4 through 7, below) rely on in situ soil treatment rather than deep excavation. For alternatives involving removal of soil "hot spots" (Alternatives 6 and 7, below), only shallow excavation in selected areas of the site is contemplated.

The alternatives employ representative process options for a given technology. Typically, several techniques are available to implement each process option. For example, various types of oil/water separator units could be used to treat groundwater.

The chemical characteristics of groundwater and soil at the site were estimated on the basis of a limited number of borings and monitoring wells. The actual physical or chemical characteristics encountered during remediation could be substantially different. For example, significant concentrations of various chemicals of interest could be found in locations where no samples had previously been collected. As a result, the extent of contamination would be greater than estimated, leading to increased costs.

9.1 ALTERNATIVE 1: NO ACTION

This alternative mandates no remediation measures, relying solely on natural attenuation mechanisms to control migration and ultimate degradation of chemicals. It would include limited monitoring as necessary to satisfy CERCLA requirements for ongoing monitoring and review to ensure that the no-action decision was still protective. Inclusion of a no-action alternative is required by the National Oil and Hazardous Substances Pollution Contingency Plan; this alternative is used as a baseline for evaluation of other alternatives.

The estimated capital cost for Alternative 1 is $25,200. No ongoing operation and maintenance would be required.

9.2 ALTERNATIVE 2: INSTITUTIONAL CONTROLS AND MONITORING

Various institutional controls would be implemented at OU NSC to limit access to the site, to restrict groundwater and land use, and to ensure that residual contamination is taken into consideration if site land use or ownership changes in the future. Each of these controls would be implemented through various Navy offices, thereby establishing a series of checks and balances responsible for some aspect of each control.

- Access Control. The PSNS Security Department (Code 1120) is responsible for overall Bremerton Naval Complex security. Only authorized personnel are permitted into the Controlled Industrial Area (CIA). Prior to entering the CIA all visitors receive a security and safety briefing. The FISC Security Department (Code OS) controls access to FISC property in a similar manner. These controls will continue to be maintained in accordance with current security requirements and it is not anticipated that additional controls will be necessary in connection with remedial measures selected for OU NSC.

- Groundwater and Land Use Restrictions. Administrative control of acceptable groundwater use and land use will be maintained by the FISC Management Planning Division (Code 41) and the Engineering Field Activity Northwest (EFA NW) Facilities Planning Division. An electronic overlay to the existing digital FISC base map would be developed reflecting restrictions of groundwater use for domestic purposes and residential land use development at FISC. This overlay would be developed by the Facilities Division of the PSNS Facilities and Maintenance Department (Code 990). The FISC Management Planning Division would consult this electronic overlay when developing projects to ensure compatibility and prevent incompatible development. EFA NW is responsible for validating FISC projects in accordance with Navy instructions (NAVFACINST 11010.44F) during the planning stage. During this validation the EFA Northwest Facilities Planning Division would also check the project to ensure compatibility with the overlay.

- Future Land Use Restrictions. Pursuant to Section 120(h)(1) of CERCLA and Part 373 of the NCP, should the United States enter into a contract for the sale or other transfer of FISC property, the United States would give notice of hazardous substances that have been stored, disposed of, or released on the property. Pursuant to Section 120(h)(3) of CERCLA the United States would include in each deed entered into for the transfer of the property a covenant stating that the remedial action(s) are completed and any additional remedial action found to be necessary after the transfer shall be conducted by the United States. In addition to the covenants required by Section 120(h) of CERCLA, the Navy is seeking GSA approval of restrictive covenants/deed restrictions to effectuate the ROD, which will be included in the conveyance document in the event of transfer of the property to a nonfederal entity. The conveyance document shall require the nonfederal transferee to record the restrictive covenants/deed restrictions with the county auditor within 30 days of transfer. Such covenants/deed restrictions will address any limits to remain in effect after the time of transfer to restrict land use, restrict the use of groundwater, and manage excavation. The deed covenants will also include provisions addressing the continued operation, maintenance, and monitoring of the selected remedy. In the event that GSA does not approve the restrictive covenants/deed restrictions by the time of the 5-year review, the ROD may be reopened.

- Best Management Practices. FISC will document those measures necessary to sustain property operating stormdrains at OU NSC in the form of a stormdrain maintenance plan. This plan will be subject to review and approval by Ecology and the EPA and will meet the objectives of the Navy's Best Management Practices (BMP) plan for the Bremerton Complex. Because stormdrain maintenance is a part of ongoing FISC operations, no costs were included under this alternative for cleaning, routine maintenance, or monitoring of the stormdrain system.

  The Navy also has a BMP program for oil-handling facilities. The program provides for yearly testing of the oil pipeline and regular inspection of both offshore and onshore oil-handling facilities (i.e., pumphouse, aboveground storage tanks, and underground storage tanks). This program has been initiated under the Navy's in-house compliance program and is separate from the CERCLA actions. Therefore, no costs were included under this alternative for testing and inspection of oil-handling facilities.

A remedial monitoring program would be implemented for OU NSC. The program would include regular annual sampling and analysis of groundwater discharging from OU NSC for any patterns that imply a change in the risks posed by the site. The specific details of the groundwater monitoring would be defined during the remedial design process. Each of the institutional controls would also be monitored as part of the remedial monitoring program.

The results of the remedial monitoring program would be reviewed at an appropriate frequency to determine whether the specific measures establishing the control remain in place or have been modified and to verify that the control is still effective. In cases of this sort, which result in hazardous substances remaining on site at concentrations exceeding regulatory levels, both MTCA and CERCLA call for review of the remedial action at least every 5 years.

The estimated capital cost of Alternative 2 is $66,000. Annual operation and maintenance (O&M) costs are estimated to be $47,800. It is estimated that 2 years would be required to implement Alternative 2.

9.3 ALTERNATIVE 3: CAPPING AND CONTAINMENT

This alternative consists of the institutional controls of Alternative 2 with improved capping of the site, including regular inspection and maintenance of the cap (paving). Two additional elements are involved: (1) an additional institutional control (development and implementation of a management plan to limit worker exposure to soils during future excavation projects at OU NSC), and (2) initial cleaning of the stormdrain system.

The existing site paving and quay wall along the waterfront of OU NSC already limit direct human contact with soil and control migration of site contaminants due to infiltration and erosion. The capping and containment measures described below are intended to maintain and improve these existing site features.

- Capping. A cap is a horizontal barrier that minimizes surface water infiltration to the underlying soils and fill, and prevents human exposure to this material.

- Most of the site is already covered by buildings and asphalt concrete pavement in good repair. This alternative would improve the existing coverage--and therefore further reduce potential contact with soils as well as infiltration--by (1) placing asphalt concrete pavement on currently unpaved areas and (2) repairing and replacing existing asphalt concrete not in good condition. An estimated 78,000 square feet would be newly paved and 156,000 square feet would be repaired or replaced. The appropriateness of seal coating site pavement to further reduce infiltration will be evaluated during the preparation of the remedial design. In the planning and design of pavement upgrades, particular attention would be given to areas around stormdrain inlets, existing low spots where surface water tends to accumulate, and to the use of grading or curbs to channel surface runoff to stormdrain inlets. The integrity of site paving would be assessed regularly as part of the remedial monitoring program.

- Excavation Management Plan. Future construction and maintenance of facilities at OU NSC will require breaching of the asphalt concrete cap whereby workers could be potentially exposed to contaminated soil. An Excavation Management Plan will be developed that will describe contaminants likely to be encountered throughout the facility. The plan will also specify who to contact concerning health and safety issues, appropriate personal protective equipment to be worn, sampling and analysis of excess soil, and proper disposal of excess soil. This plan will be maintained in the FISC Facilities and Maintenance Division (Code 702B) and the PSNS

Facilities and Maintenance Department (Code 910C) and will be consulted when outage requests are made that require breaching the asphalt concrete cap.

- Stormdrain Cleaning. For this alternative, it was assumed that the initial cleaning of the stormdrain lines and catch basins at OU NSC would be completed as a CERCLA action and that, once cleaned, the future maintenance of the stormdrain components would be conducted as a part of ongoing FISC maintenance programs. The maintenance activities will be monitored and reported as part of the remedial monitoring program. Therefore, capital costs were included in the capping and containment alternative for initial cleaning of the stormdrain system, but not for routine maintenance and monitoring.

The estimated capital cost of Alternative 3 is $2,628,000. Estimated annual O&M cost is $161,600. It is estimated that 3 years would be required to implement Alternative 3.

9.4 ALTERNATIVE 4: IN SITU SOIL TREATMENT AND GROUNDWATER EXTRACTION

This alternative includes all of the measures of Alternative 3 (i.e., institutional controls, asphalt capping measures, excavation management plan, and stormdrain system cleaning). Two additional elements are included: (1) in situ bioventing to promote biodegradation of TPH- and PAH-contaminated soil where concentrations of these chemicals are highest, especially along Wycoff Way and W Street, and (2) extraction of TPH-contaminated groundwater.

- Bioventing. The major components of a bioventing system are (1) blowers and injection wells to introduce air (oxygen) into the subsurface soils, (2) vent wells to allow passive venting of the injected air, and (3) soil gas monitoring probes to measure soil vapor conditions (e.g., oxygen content, pressure, and temperature). Laboratory and field tests would be required to establish preliminary design information.

- Groundwater Extraction. Five new groundwater extraction wells were assumed to be necessary, four in the vicinity of the intersection of W Street and Wycoff Way and one near Building 588. Since the objective is to remove primarily oil rather than groundwater, the wells would be pumped intermittently, allowing rest periods for oil to move into the wells.

- Groundwater Treatment. Oil/water treatment units used at the Bremerton Complex to treat oily bilgewater from vessels appear suitable for treatment of extracted oily groundwater. Extracted groundwater would be processed to remove oil and treated as required for discharge to the City of Bremerton sewer system. Predesign laboratory and pilot tests of the groundwater treatment process would be required.

- Treated Groundwater Disposal. Treated groundwater would be discharged to the municipal sewer along with treated bilgewater.

The estimated capital cost of Alternative 4 is $6,709,000. Annual O&M costs are estimated to be $714,600. An estimated 4 years would be required to implement Alternative 4. In situ treatment would likely continue for an indefinite period.

9.5 ALTERNATIVE 5: IN SITU SOIL TREATMENT AND IN SITU GROUNDWATER TREATMENT

This alternative is the same as Alternative 4, except that TPH-contaminated groundwater would be treated in situ instead of being extracted, pretreated, and discharged to the municipal wastewater treatment plant. Through newly installed injection wells, oxygen and nutrients would be added to the groundwater to promote the aerobic degradation of TPH and PAH chemicals in the groundwater. Predesign laboratory and pilot tests of bioventing and groundwater bioremediation would be required.

The estimated capital cost of Alternative 5 is $6,938,000. Estimated annual O&M costs are $570,600. An estimated 4 years would be required to implement Alternative 5, with in situ treatment continuing.

9.6 ALTERNATIVE 6: IN SITU SOIL TREATMENT, GROUNDWATER EXTRACTION, AND HOT SPOT SOIL REMOVAL

This alternative is similar to Alternative 4 except that contaminated soil from "hot spots" would be removed and shipped off site for treatment and disposal. Such removal would occur only where high concentrations of chemicals of concern (lead, cPAHs, TPH) are known to exist and where excavation is practical. Great uncertainty is associated with soil excavation in heterogeneous fill/debris; the amount of soil to be removed at each hot spot and the associated costs could vary considerably depending on field conditions encountered during the excavation. Rigorous sampling to locate all possible hot spots would be prohibitively expensive and impractical. Instead, after the initial hot spots had been removed, additional hot spots would be identified in the course of the sampling required under the excavation management plan (see Alternative 3). It is estimated that 6,800 cubic yards of soils would be excavated.

The estimated capital cost of Alternative 6 is $10,975,000. Estimated annual O&M costs are $714,600. An estimated 5 years would be required to implement Alternative 6, with in situ treatment continuing.

9.7 ALTERNATIVE 7: IN SITU SOIL TREATMENT, IN SITU GROUNDWATER TREATMENT, AND HOT SPOT SOIL REMOVAL

The difference between this alternative and Alternative 6 is only that groundwater would be treated via in situ bioremediation (as in Alternative 5) instead of extraction methods (as in Alternative 4). Other elements are the same.

The estimated capital cost of Alternative 7 is $11,204,000. Estimated annual O&M costs are $570,600. An estimated 5 years would be needed for implementation, with in situ treatment continuing.

10.0 COMPARATIVE ANALYSIS OF ALTERNATIVES

CERCLA, as amended by SARA, requires that the specific statutory requirements listed below be addressed in the Record of Decision (ROD) and supported by the administrative record. Under CERCLA, remedial actions must meet these requirements:

- Protect human health and the environment
- Attain ARARs unless justifications are provided for invoking a waiver
- Be cost-effective
- Use permanent solutions and alternative technologies or resource recovery technologies to the maximum extent practicable
- Satisfy the preference for treatment that reduces toxicity, mobility, or volume

In addition, CERCLA emphasizes long-term effectiveness and encourages the evaluation of innovative technologies.

To address these requirements, EPA has developed nine evaluation criteria as the basis for the detailed feasibility study evaluation and, subsequently, for selecting an appropriate remedial action. EPA groups the nine criteria into the following three categories, based on each criterion's role during remedy selection.

- Threshold criteria
    - Overall protection of human health and the environment
    - Compliance with ARARs
- Primary balancing criteria
    - Long-term effectiveness and permanence
    - Reduction in toxicity, mobility, or volume through treatment
    - Short-term effectiveness
    - Implementability
    - Cost
- Modifying criteria
    - State acceptance
    - Community acceptance

A description of each criterion is presented below.

- Overall protection of human health and the environment addresses whether adequate protection is provided during and after remedial activities.
- Compliance with ARARs addresses whether the alternative meets all applicable or relevant and appropriate requirements of federal and state laws and regulations.
- Long-term effectiveness and permanence refers to the ability of the remedy to maintain reliable protection of human health and the environment over time once cleanup levels have been met.

- Reduction of toxicity, mobility, or volume through treatment is the anticipated performance of the treatment technologies.

- Short-term effectiveness refers to how quickly the remedy achieves protection and the remedy's potential to adversely impact human health and the environment during construction and implementation.

- Implementability is the technical and administrative feasibility of a remedy, including the availability of materials and services needed.

- Cost includes capital costs, operation and maintenance costs, and present-worth cost estimates including inflation.

- State acceptance refers to whether the alternative addresses the technical and administrative concerns of the state.

- Community acceptance pertains to whether the alternative adequately addresses concerns of the local community.

Table 10-1 summarizes the comparison of the cleanup alternatives to these criteria. This comparison is discussed in more detail in the text that follows.

Table 10-1
Comparison of Cleanup Alternatives to Criteria

Criterion	Alternative 1: No Action	Alternative 2: Institutional Controls and Monitoring	Alternative 3: Stormdrain Cleaning and Improved Capping	Alternative 4: In Situ Soil Treatment and Groundwater Extraction	Alternative 5: In Situ Soil and Groundwater Treatment	Alternative 6: In Situ Soil Treatment, Groundwater Extraction, and Limited Soil Removal	Alternative 7: In Situ Soil and Groundwater Treatment and Limited Soil Removal
Overall protection of human health and the environment	No reduction in risk	Access restrictions reduce potential for contact with contamination	Reduced chance of contact with soil; stormdrain contaminants removed	Reduced chance of contact with soil; stormdrains cleaned; limited reduction of organic contaminants	Reduced chance of contact with soil; stormdrains cleaned; limited reduction of organic contaminants	Reduced chance of contact with soil; stormdrains cleaned; moderate reduction of other contaminants	Reduced chance of contact with soil; stormdrains cleaned; moderate reduction of other contaminants
Compliance with ARARs	State requirements not met	State requirements met via institutional controls	State requirements met via access control, improved capping, and removal of stormdrain contaminants	State requirements met via access control, improved capping, stormdrain contaminant removal, and reduction of soil organics and groundwater metals and organics	State requirements met via access control, improved capping, removal of stormdrain contaminants, and reduction of soil and groundwater organics	State requirements met via access control, improved capping, removal of stormdrain contaminants, and reduction of soil and groundwater metals and organics	State requirements met via access control, improved capping, removal of stormdrain contaminants, and reduction of soil and groundwater metals and organics
Long-term effectiveness and permanence	None	With limited maintenance, pavement will deteriorate, exposing soil, stormdrain sediments can impact Inlet	Access limitations, containment, and removal of stormdrain contaminants effective if maintained	Access limitations, containment, and removal of stormdrain contaminants effective if maintained; treatability studies required	Access limitations, containment, and removal of stormdrain contaminants effective if maintained; treatability studies required	Access limitations, containment, and removal of stormdrain contaminants effective if maintained; treatability studies required; hot spot removal effectively reduces a source of contamination	Access limitations, containment, and removal of stormdrain contaminants effective if maintained; treatability studies required: hot spot removal effectively reduces a source of contamination

Table 10-1 (Continued)
Comparison of Cleanup Alternatives to Criteria

Criterion	Alternative 1: No Action	Alternative 2: Institutional Controls and Monitoring	Alternative 3: Stormdrain Cleaning and Improved Capping	Alternative 4: In Situ Soil Treatment and Groundwater Extraction	Alternative 5: In Situ Soil and Groundwater Treatment	Alternative 6: In Situ Soil Treatment, Groundwater Extraction, and Limited Soil Removal	Alternative 7: In Situ Soil and Groundwater Treatment and Limited Soil Removal
Reduction of toxicity, mobility, or volume through treatment	None	No treatment	No treatment	Limited reduction of metals and organic compounds	Limited reduction of organic compounds	Moderate reduction of metals and organic compounds	Moderate reduction of metals and organic compounds
Short-term effectiveness	None	Institutional controls effective	Institutional controls effective; eliminates stormwater contaminants having direct pathway to Inlet	Institutional controls effective; eliminates stormwater contaminants	Institutional controls effective; eliminates stormwater contaminants	Institutional controls effective; eliminates stormwater contaminants and some contaminated soils	Institutional controls effective; eliminates stormwater contaminants and some contaminated soils
Implementability	Not applicable	Readily implemented	Careful planning and coordination will minimize chance of conflict with site usage utilities probable; treatability studies required	Careful planning and coordination required; conflicts with site usage and utilities probable; treatability studies required	Careful planning and coordination required; conflicts with site usage and treatability studies required	Careful planning and coordination required; conflicts with site usage and utilities probable; utilities probable; treatability studies required	Careful planning and coordination required; conflicts with site usage and utilities probable; treatability studies required
Costs:							
Capital	$25,200	$66,000	$2,628,000	$6,709,000	$6,938,000	$10,975,000	$11,204,000
Operation/maintenance a	$0:0	$47,800:$207,000	$161,600:$700,000	$714,600:$3,093,000	$570,600:$2,470,000	$714,600;$3,093,000	$570,600:$2,470,000
Total present Worth b	$25,200	$273,000	$3,328,000	$9,802,000	$9,408,000	$14,068,000	$13,674,000

a Operation and maintenance costs are presented as both annual cost and present worth costs in the following form--(annual cost):(present worth cost of five years of operation and maintenance)
b Total present worth cost equals the total equivalent cost of the alternative over 5 years in current dollars.

10.1 OVERALL PROTECTION OF HUMAN HEALTH AND THE ENVIRONMENT

All seven alternatives described in Section 9 are protective of human health, provided the site remains paved to limit exposure to subsurface soils. The probability is high that the site will remain paved since the Navy intends to maintain control of the site and retain site paving. Alternatives 2 through 7 enhance this protectiveness through institutional controls that restrict use of the site to exclude future residential use.

Given the protectiveness of deed restrictions, as long as the site remains paved subsurface soils are of concern only to future construction workers who may work for extended periods at the site. Alternatives 3 through 7 provide additional protection to future workers through the development of an excavation management plan designed to limit worker exposure to soil during future excavation activity. Alternative 3 provides greater protection than Alternative 2 by improving the capping of the site; paving and possible seal-coating will reduce potential for exposure via direct contact and reduce contaminant migration to groundwater and surface water due to infiltration. Alternatives 4 through 7 are incrementally more protective of human health compared with the other alternatives because treatment of soils would reduce the concentrations of organic chemicals of concern in the soil. Alternatives 6 and 7 offer the greatest protection by also providing for removal of some soil hot spots.

Groundwater does not pose a human health risk because it is neither a current nor a potential future source of drinking water at this site. Contaminated groundwater may, however, constitute an environmental risk to Sinclair Inlet. Contaminant migration via groundwater from the site to Sinclair Inlet is currently believed to be minor. The groundwater pathway and marine environment adjacent to the Bremerton Complex will be further evaluated during the OU B remedial investigation. The results of the OU B investigation could suggest a need for future reconsideration of groundwater at OU NSC. If the OU B investigation establishes that additional remedial measures are necessary at OU NSC, these measures will be defined in the OU B ROD.

The remediation of groundwater provided in Alternatives 4 through 7 further reduces the contaminant load in the groundwater. These alternatives are thus incrementally more protective of the environment.

Stormdrain cleaning included in Alternatives 3 through 7 would further protect the environment by assuring prompt removal of contaminated stormdrain sediments, which represent a direct source of contamination to Sinclair Inlet.

10.2 COMPLIANCE WITH ARARS

MTCA Method C standards for industrial soil are applicable to OU NSC. Where MTCA Method C standards do not exist for a chemical, laboratory results were compared to MTCA Method A standards. The volume of contaminated soil present at the site cannot be accurately established because highly heterogeneous fill materials make up the site. Soil concentrations were higher than regulatory maximum values primarily for TPH, lead, and PAHs.

MTCA Method B surface water standards, state and federal water quality criteria, and the National Toxics Rule are also applicable to OU NSC. Groundwater concentrations were higher than these regulatory maximum values at the site primarily for TPH and inorganics.

The no action alternative does not comply with MTCA since action is required to reduce site risks. The other alternatives comply with MTCA but vary in how compliance with MTCA will be achieved. For example, capping, included in Alternatives 3 through 7, complies with MTCA by restricting exposure to contaminants. Institutional controls are necessary to ensure that the cap remains in compliance with MTCA. The more active measures (stormdrain cleaning, soil treatment and removal, etc.) are preferred by MTCA over institutional controls and containment since they achieve compliance by reducing concentrations of contaminants.

10.3 LONG-TERM EFFECTIVENESS AND PERMANENCE

Alternative 1 does not enhance the long-term effectiveness or permanence of human health and environmental protection.

Alternative 2 is somewhat deficient with regards to long-term effectiveness and permanence, since pavement will gradually deteriorate if not maintained, potentially leading to contact with site soils. Accumulated stormdrain sediments are also likely to continue to discharge contaminants to Sinclair Inlet.

Enhanced capping and removal of stormdrain sediments, included in Alternatives 3 through 7, reduce the chance of contact with soils, limit transport of chemicals to groundwater by infiltration, and remove contaminated stormdrain sediments. Thus these alternatives significantly increase the long-term effectiveness and permanence of human health and environmental protection.

Alternatives 4 through 7, which treat soils and groundwater and thus reduce the amount of site contamination and residual risk, further increase the long-term effectiveness and permanence. The effectiveness of treatment (bioventing) would have to be established with treatability studies. Natural processes may also gradually eliminate organic compounds such as TPH and PAHs, but due to site-specific conditions this may take a very long time. In addition, the source of TPH contamination has not been identified. Inorganics do not naturally attenuate. Alternatives 6 and 7 have the highest level of long-term effectiveness and permanence since hot spots of contamination would be removed from the site.

10.4 REDUCTION OF TOXICITY, MOBILITY, AND VOLUME THROUGH TREATMENT

Alternatives 1 through 3 do not include any treatment measures. Alternatives 4 through 7 utilize treatment to reduce the volume and toxicity of chemicals of concern in both the groundwater and soils. Bioventing, included in Alternatives 4 through 7, would reduce the levels of organic chemicals of concern in the soils. The quantity of contaminants removed is increased, and inorganic chemicals of concern are addressed in Alternatives 6 and 7 through excavation of soil hot spots.

Groundwater extraction and treatment, included in Alternatives 4 and 6, would provide slightly greater reduction in concentration of chemicals of concern than would the in situ bioremediation in Alternatives 5 and 7, since in situ bioremediation addresses only organic compounds.

The greatest reduction in volume and toxicity of chemicals of concern through treatment would be provided by Alternative 6, followed by 7, 4, and 5 in descending order of degree of chemical removal.

10.5 SHORT-TERM EFFECTIVENESS

Stormdrain cleaning, included in Alternatives 3 through 7, is quite effective in promptly eliminating a source of contamination to the environment. Additional short-term benefits are associated with removal of soil hot spots, included in Alternatives 6 and 7.

Alternatives 3 through 7, which involve significant construction activity, are inherently more risky to workers and the community than Alternatives 1 and 2. Risks associated with excavation (included in Alternatives 6 and 7) would likely be somewhat greater than those associated with bioventing, bioremediation, and groundwater extraction and treatment. Short-term risks to workers during construction would be mitigated by use of protective clothing and equipment, dust control, and other measures.

10.6 IMPLEMENTABILITY

Although close coordination with existing site activities will be required, both the stormdrain cleaning and capping actions included in Alternatives 3 through 7 can be implemented relatively readily.

Although the excavation and treatment actions of Alternatives 4 through 7 are technically feasible, implementation is likely to be difficult because of space restrictions, conflicts with existing site activities, and subsurface obstacles at the site. Treatability studies are required for the bioventing component of Alternatives 4 through 7 and for the in situ groundwater treatment in Alternatives 5 and 7. Treatability, studies may also be required for treatment of extracted groundwater in Alternatives 4 and 6. Conflicts with site usage and utilities presented by the treatment measures in Alternatives 4 through 7 substantially limit the technical possibility of implementing these alternatives, as acknowledged in MTCA 173-340-360(5)(d)(v).

In general, the more activity involved in construction and operation of an alternative, the more likely it is that difficulties will be encountered during implementation.

10.7 COST

Capital, operation and maintenance, and present worth costs are summarized in Table 10-1. Based on EPA guidance, the cost estimates were developed to be accurate to a range of -30 percent to +50 percent, given the available information. Thus an estimated cost of $1,000,000 represents a range of probable costs between $700,000 and $1,500,000.

The substantial incremental cost of Alternatives 4 through 7 appears to be disproportionate to the limited increase in protectiveness afforded by these alternatives. MTCA 173-340-360(5)(d)(vi) specifically allows for consideration of this issue in selecting an appropriate remedy.

10.8 STATE ACCEPTANCE

Ecology has reviewed the information available about this site and the several remedial alternatives proposed. Ecology concurs with the selected remedy as the best balance of protection for human health and the known needs of the environment and the technical and economic practicality of further measures. The selected remedy thus meets state and federal requirements. If the investigation being performed for OU B at the Bremerton Naval Complex indicates further reduction of groundwater contaminant levels is necessary for the protection of the marine environment, further actions on groundwater at OU NSC will be performed under the ROD for OU B.

10.9 COMMUNITY ACCEPTANCE

Comments received during the public comment period indicate that the public accepts the selected remedial action for OU NSC.

11.0 THE SELECTED REMEDY

Based on consideration of MTCA and CERCLA requirements, the detailed analysis of remedial alternatives using the nine EPA criteria, and the public comments received, both Ecology and the EPA agree with the Navy that Alternative 3 is the most appropriate remedy for OU NSC at the Bremerton Naval Complex.

The selected remedy includes the following components:

Actions

- Measures to enhance existing site paving. These will further reduce the potential for human contact with soils, either directly or in the form of airborne particles. The measures will also decrease the opportunity for precipitation to pass through the soil and potentially transport chemicals to the groundwater. Improvements to the pavement will include placement of pavement in those limited areas not already paved; repairs to pavement, for example in areas where pavement has settled or cracked; and modifications to existing pavement to eliminate low spots and direct surface runoff to stormdrain inlets. Depending on the conclusions of an evaluation to be performed during remedial design, seal coating may also be applied to some or all of the pavement at the site. An estimated 78,000 square feet of new pavement would be placed at the site and repairs would be made to an estimated 156,000 square feet of existing pavement. Repairs to pavement required in the future would be performed as part of ongoing FISC maintenance programs.

- Accumulations of soil, fill, and miscellaneous debris that clog many of the stormdrain lines at OU NSC will be removed from the lines and disposed of appropriately. An initial step in this task will likely be to perform videotaping or closed-circuit television (CCTV) inspection of selected sections of the stormdrains to identify potential problem areas and plan the cleaning. Precautions will be taken to minimize the potential for discharge of debris to Sinclair Inlet during the cleaning operation. It is anticipated that damage will be encountered in some stormdrain lines; critical repairs will likely be performed in conjunction with the cleaning operations. Removal of sediments and debris will likely be performed with truck-mounted vacuum units specifically designed for this purpose. Subsequent to the cleaning, sampling and analysis of selected stormdrains will be performed to confirm the results, possibly supplemented by videotaping or CCTV inspections. Removal of soil, fill, and debris from the stormdrain system will substantially reduce the potential for contaminants to be transported to Sinclair Inlet, either as suspended material or dissolved in storm runoff. A detailed plan for maintenance of OU NSC stormdrains after cleaning will be developed during the remedial design process.

Institutional Controls

- Specific institutional controls will be implemented at OU NSC. These controls, described in Subsections 9.2 and 9.3, serve to limit access to the site through existing site security procedures, restrict groundwater and land usage, and ensure that residual site contamination is taken into consideration if site land use or ownership changes in the future.

- Ongoing Navy operations at the Bremerton Naval Complex will inevitably require soil excavation in connection with new construction and maintenance of existing facilities. Future excavations at OU NSC will breach the asphalt pavement that caps the site, and may temporarily expose workers to contaminants, through contact with soil or airborne particles. To control the resulting human health risks, the Navy will develop an excavation management plan with which all future construction projects will be required to comply. The plan, customized for OU NSC, will be coordinated with similar plans being prepared for the rest of the Bremerton Complex. The plan will require contractors to coordinate with FISC management prior to any excavation activity; it will also identify clearances required for excavation, training and health and safety precautions required of workers, and chemicals likely to be encountered on site. The plan will require that the nature of the soils be established by sampling and analysis prior to excavation to determine if project-specific health and safety and soil handling/disposal measures are required.

Monitoring

- The Navy will develop and implement a plan for regular environmental monitoring at OU NSC, subject to review and approval by Ecology and the EPA. The monitoring will include annual sampling and analysis of groundwater to ensure that trends in contaminant levels remain acceptable. Each of the institutional control measures will also be monitored to ensure that their effectiveness is maintained. As noted below, several ongoing Navy studies and planned programs have potential implications for OU NSC, and the monitoring program will also take these other issues into consideration. The details of the monitoring plan will be developed during the remedial design process.

Review

- The results of the remedial action and environmental monitoring program will be reviewed with Ecology and the EPA at least every 5 years.

The selected remedy has an estimated total present worth cost of $2.6 million. Approximately 65 percent of this cost is for stormdrain cleaning, 5 percent for upgrading of pavement, and the remainder for other aspects of the remedial alternative, including institutional controls, development of the excavation management plan, and ongoing monitoring. Approximately 3 years are projected to be needed to implement the selected remedy.

Residual contamination would remain at the site after the selected remedy is implemented. Contaminants would remain in soils at the site. Petroleum would continue to be present floating on the groundwater. In addition, unless maintenance of site facilities is performed on a regular basis, risks posed by remaining site contaminants could increase. For example, neglect of the stormdrain system could lead to reaccumulation of contaminants in catchbasins, and failure to maintain site pavement would increase the chance of contact with contaminated soils. The condition of the stormdrains will be monitored as part of the FISC maintenance program. The integrity of site paving will be monitored as part of the remedial monitoring program.

Petroleum contamination is known to be common in many parts of the Bremerton Complex. The Navy is presently developing a program to guide and sequence TPH cleanup throughout the Complex and at other Navy sites in Washington State to assure that those areas of contamination that appear to constitute the greatest threats to the environment receive priority. The source of petroleum contamination at OU NSC has not been identified. The contamination may extend beyond OU NSC. Like groundwater, TPH will be addressed on a site-wide basis.

No specific actions to remediate groundwater are being undertaken as part of this ROD. There is limited evidence that groundwater draining into Drydock 6 from the OU NSC region may contain inorganic chemicals at concentrations above surface water regulatory levels. However, as a result of mixing and dilution within the drydock, this groundwater does not appear to have a significant impact on Sinclair Inlet. A remedial investigation currently being performed for Operable Unit B at the Bremerton Complex includes the use of computer modeling to evaluate groundwater behavior throughout the Complex as well as a comprehensive evaluation of the marine environment adjacent to the Complex. The results of these investigations are of considerable significance for OU NSC. If the groundwater from this site is determined to be contributing to unacceptable chemical impacts on the marine environment, additional measures addressing groundwater may be required. Any additional remedial measures found to be necessary for OU NSC as a result of the OU B evaluation will be defined in the ROD for OU B.

Sampling of stormdrains as part of shipyard NPDES monitoring will also produce information relevant to the remediation of OU NSC, which should be considered during future reviews of the cleanup of the site.

The selected remedy will fulfill the remedial action objectives (RAOs) and remedial goals (RGs) developed in Section 8. The soil RAOs are based on protection of current and future site workers and the soil RGs are based on industrial site usage. Potential worker exposure will be limited by capping unpaved areas, maintenance of the cap, and appropriate management of soil excavation during construction activities through the excavation management plan.

The groundwater RAOs will be met by paving unpaved areas, modifying the surface to improve drainage, cleaning the stormdrain system, and sealing appropriate parts of the surface to further reduce surface water intrusion and infiltration through contaminated soils. Groundwater will be monitored to determine if contaminant trends remain acceptable.

The RAOs for stormdrain media will be met by the initial stormdrain cleaning and ongoing FISC maintenance.

The site-wide groundwater modeling and risk assessment for OU B will establish whether further measures are needed to protect Sinclair Inlet. Additional soil and groundwater RGs for the protection of the Inlet will be developed, if appropriate, in the OU B ROD.

12.0 STATUTORY DETERMINATION

Under CERCLA, selected remedies must be protective of human health and the environment, comply with ARARs, be cost effective, and use permanent solutions and alternative treatment technologies or resource recovery technologies to the maximum extent practicable. CERCLA also includes a preference for remedies that employ treatment to permanently and significantly reduce the volume, toxicity, or mobility of hazardous wastes as their principal element. The following sections discuss how the selected remedy meets these statutory requirements.

12.1 PROTECTION OF HUMAN HEALTH AND THE ENVIRONMENT

Alternative 3 protects human health through several measures that prevent contact with contaminated soils, the only medium identified as constituting a risk to humans at OU NSC. Institutional controls will limit site access and restrict land usage. Institutional controls should remain effective over the long term due to the Navy's high level of control. Enhancement of site paving will control potential exposure of industrial site workers to soil. Implementation of an excavation management plan will alleviate possible soil contact by construction workers. These measures will be maintained over the long term to ensure protectiveness.

The selected remedy is protective of the environment, since cleaning of storm drains at OU NSC will remove a threat presented by the site to the marine environment. As long as it is followed up with regular maintenance the stormdrain cleaning should be highly protective in the long term. The conclusion of the remedial investigation was that, under present conditions, transport of chemicals by groundwater from OU NSC to Sinclair Inlet does not present a substantial environmental risk. By limiting the opportunity for precipitation to enter the soil, improvements to paving at OU NSC will, nevertheless, provide the secondary benefit of reducing potential transport of chemicals from soil to the groundwater.

12.2 COMPLIANCE WITH ARARS

The selected remedy for OU NSC will comply with federal and state ARARs that have been identified. No waiver of any ARAR is being sought or invoked for any component of the selected remedy.

12.2.1 Action-, Chemical-, and Location-Specific ARARs

- Washington State Hazardous Waste Management Act - Model Toxics Control Act (RCW 70.105D, WAC 173-340)

Several provisions of MTCA are applicable to the selected remedy. For example, those parts of WAC 173-340-360 pertaining to the order of preference in selecting cleanup technologies and establishing the restoration timeframe are applicable. WAC 173-340-704, -705, and -706 are applicable because they identify the conditions under which Method A, B, and C values, respectively, are to be used. Other sections of MTCA that are applicable to OU NSC are WAC 173-340-720, which defines cleanup standards for groundwater, 173-340-730, which defines cleanup standards for surface water, 173-340-740 and -745, which define cleanup standards for soil and industrial soil, and 173-340-760, which defines sediment cleanup standards.

- Washington State Dangerous Waste Regulations (WAC 173-303)

Procedures to be used to designate waste as dangerous and the standards for handling, transporting, storing, and treating designated waste are applicable to sediments and debris collected from stormdrains and investigation-derived waste.

- Resource Conservation and Recovery Act (RCRA) (42 USC 6901 and 40 CFR 260-281)

RCRA Subtitle C (40 CFR 261, 262, 263, and 268) requirements relating to solid waste identification, storage, manifesting, transport, treatment, and disposal are applicable to sediments and debris to be collected from stormdrains.

- CERCIA "Off-Site Rule" (40 CFR 300-440)

Applicable to the selection of any off-site treatment, storage, or disposal of CERCLA hazardous substances.

- (State of Washington) Transportation of Hazardous Waste Materials (WAC 446-50)

Requirements related to the transportation of hazardous materials using the public highways of the state are applicable if sediments and debris collected from stormdrains are determined to be hazardous.

- (Federal) Hazardous Materials Regulations (49 CFR Subchapter C, Parts 107 and 171-180)

Requirements related to the containerization and transportation of hazardous materials are applicable if sediments and debris collected from stormdrains are determined to be hazardous.

- (Washington State) Minimal Functional Standards for Solid Waste Handling (WAC 173-304)

Requirements related to the management of non-hazardous materials are applicable to sediments and debris collected from stormdrains which are determined to be hazardous.

- Washington State Water Pollution Control Act (RCW 90.48)

Standards for surface water body use classification and marine water quality standards are applicable to stormdrain cleaning.

- Washington State Sediment Management Standards (WAC 173-204)

Applicable (for example, because of requirements to control potential sources of contamination to marine sediments, such as during stormdrain cleaning operations).

- Washington State Clean Air Act (RCW 70.94)

Requirements for control of fugitive dust are applicable.

- Federal Clean Air Act (42 USC 7401)

Requirements for control of fugitive dust are applicable.

- Washington State General Regulations for Air Pollution Sources (WAC 173-400)

Requirements for control of fugitive dust are applicable.

- Puget Sound Air Pollution Control Agency Regulation 1, Section 9.15

Requirements for control of fugitive dust are applicable.

- Washington State Water Quality Standards for Surface Water (WAC 173-201A)

Applicable because these standards define use classifications and water quality standards for surface water bodies including marine waters such as Sinclair Inlet within the state.

- Federal Water Quality Criteria for Surface Water and National Toxics Rule (40 CFR 131)

Criteria for the protection of aquatic life and to control human health risks due to consumption of aquatic organisms are applicable to stormdrain water discharges.

12.2.2 Other Standards To Be Considered

- Authorization to Discharge under the National Pollutant Discharge Elimination System (Permit No. WA-000206-2 for Bremerton Naval Complex, April 1, 1994)

Requirements relating to management of stormdrain facilities (e.g., regarding effluent limitations, monitoring requirements, and best management practices) should be considered in implementing the selected remedy.

- RCRA Permit for Bremerton Naval Complex

Management practices identified in the permit for handling hazardous materials should be considered in implementing the selected remedy.

Washington State Department of Ecology's Statistical Guidance for Site Managers, together with Supplement 6 to the guidance document.

12.3 COST-EFFECTIVENESS

Alternative 1 is not protective of human health and the environment and does not meet state requirements. Alternative 2 is somewhat more protective of human health and the environment and meets state requirements, although it does not satisfy the preference for active remedial measures. Of Alternatives 3 through 7, which do meet these two requirements, Alternative 3 is considerably less costly than the others. The total present worth cost of Alternative 3 is approximately $3.3 million compared to a range of $9.4 million to $14.1 million for Alternatives 4 through 7. The increase in cost of Alternatives 4 through 7 compared to Alternative 3 is substantial and not warranted considering the moderate improvement in the extent of cleanup likely to be achieved by Alternatives 4 through 7. Alternative 3 is believed to be the most cost-effective remedy that is protective of human health and the environment.

12.4 UTILIZATION OF PERMANENT SOLUTIONS AND ALTERNATIVE TREATMENT TECHNOLOGIES OR RESOURCE RECOVERY TECHNOLOGIES TO THE MAXIMUM EXTENT PRACTICABLE

The selected remedy for OU NSC represents the maximum extent to which permanent solutions can be utilized in a cost-effective, practicable manner. Alternatives 4 through 7 are somewhat more effective than the selected remedy at attaining a permanent solution by removing a greater quantity of contaminants by treatment and soil removal. However, none of these alternatives can be considered a completely permanent solution. The incremental costs of Alternatives 4 through 7 compared to Alternative 3 are substantial and are disproportionate to the modest improvement in protectiveness. Since OU NSC is expected to remain an industrial site, Alternative 3 represents the best balance between protectiveness and cost-effectiveness. The Navy's high level of control ensures enforcement of institutional controls and ongoing maintenance of the cap.

12.5 PREFERENCE FOR TREATMENT AS PRINCIPAL ELEMENT

The evidence to date implies that contaminants present at OU NSC and potentially subject to treatment do not pose a significant human health risk (assuming industrial use) or environmental risk. The large volume of heterogeneous and potentially contaminated fill materials making up the site suggest that to be truly effective treatment would have to be performed on a comparatively large scale. Such an undertaking would be technically impractical given the site characteristics, including ongoing industrial activity, the prevalence of paving and buildings, and an abundance of underground utilities. Although Alternatives 4 through 7 do utilize treatment to a limited extent, the substantial cost of doing so is disproportionate to the limited improvement achieved. For these reasons, the selected remedy does not utilize treatment.

13.0 DOCUMENTATION OF SIGNIFICANT CHANGES

The only significant change from the final feasibility study and proposed plan that has occurred in preparing this ROD is that the effectiveness of proposed seal coating of pavement at the site will be evaluated during the remedial design process. A determination will be made at that time as to what portions of the site will be seal coated.

APPENDIX A

Responsiveness Summary

This responsiveness summary addresses the public comments received on the proposed plan for remedial action for OU NSC at the Bremerton Naval Complex. Several verbal comments were received at the Public Meeting held on March 5, 1996 at the Central Kitsap County Regional Library in Bremerton, Washington, and, where possible, immediate responses were provided. The verbal comments and responses provided during the Public Meeting are summarized below; complete transcripts of the Public Meeting are available in the information repositories. One written comment was also received at the Public Meeting.

1. Comment: (oral comment made by (b) (6) at Public Meeting) In the cleaning of stormdrains, I presume you inject them. How do you capture all the material that you break loose?

Response: (summary of response provided by Paul Johanson at Public Meeting) The details of the stormdrain cleaning have not yet been worked out. During the stormdrain cleaning done as part of the soil removal operation at DRMO, "Vactor" trucks, which rely on a vacuum and flexible hose, were used. Some form of jetting may be necessary to loosen clogged material, and care will have to be exercised to block the lower end of the stormdrain lines.

Subsequent Response: The details of the process to be used in cleaning out the stormdrains will be established when work plans for the remedial design are prepared. These work plans will be available for public review.

2. Comment: (oral comment made by (b) (6) at Public Meeting) How and where are the soil and other debris [from stormdrain cleaning] disposed of?

Response: (summary of response provided by Paul Johanson at Public Meeting) They would be disposed of like other solid waste. The wastes would be sampled and analyzed to determine if they are hazardous. If not hazardous the wastes can be disposed of at any of several conventional landfills. Otherwise they will have to be sent to a landfill specifically designed to take hazardous wastes.

Subsequent Response: If the sediments are determined to be hazardous, stabilization may be required prior to landfill disposal.

3. Comment: (summary of oral comment made by (b) (6) at Public Meeting) I appreciate that the alternative that was chosen is in the middle of the continuum of costs presented. But as I look at the risk assessment finding that was prepared by URS, it occurs to me that this is a gathering of negative findings. There is no risk that is identified. The risk to the marine environment is not part of the study. That's being done by an entirely different study. There are negligible risks, some potential if the soils are exposed. But there are no plans to expose them unless they are excavated because of the remediation. And then potential future risk is unlikely. So my comment is why are we spending $3.5 million when there has been no risk associated with this particular site? If there is a risk, why isn't that in the risk assessment findings? If we haven't calculated [an ecological risk] and we don't know about it and it is not listed, why are we spending money now to fix it?

Response: (summary of response provided by Ruth Thompson at Public Meeting) The risks calculated for OU NSC so far are related to human health. Ecological risk is being studied separately. Because the stormdrains are not accessible to someone working at the site, the materials in the stormdrains do not represent a human health risk. However, we do know there are heavy metals [in the stormdrains], and we believe these are at levels that represent a risk to Sinclair Inlet. That is the risk we are trying to mitigate now. It's true we don't really have details on how much risk there is.

(summary of additional response provided by Patty McGrath at Public Meeting)[It's true that the material found in the stormdrains] often exceeded various standards and is "bad stuff."

Subsequent Response: Although no ecological risk assessment has been performed for OU NSC, exceedances of regulatory criteria by stormdrain water and sediments collected at the site indicate that discharges of stormwater and sediment may present an environmental risk. Consequently it is logical to place a priority on cleaning up the sediments.

Contaminated soils are the other primary source of risk at the site. Most of the other measures included in the selected remedy are intended to reduce the potential for contact with site soils. Examples of remedy elements designed to address this issue are enhancement of existing paving, placement of additional pavement, and development of an excavation management plan.

4. Comment: (summary of oral comment made by (b) (6) at Public Meeting) Isn't the need for stormdrain cleaning a result of delays in maintenance which should have been performed independent of the remediation?

Response: (summary of response provided by Barry Rogowski at Public Meeting) According to the current NPDES permit the Shipyard and the Supply Center are supposed to be cleaning out their stormdrains. Although they have begun this process, only about 10 percent of the stormdrains have been cleaned in the 2 or 3 years the cleaning was supposed to be going on. What we'd like is for the Navy to go ahead [as part of the remediation] and clean out all of the material that has accumulated in the last few decades and then have the Shipyard take over routine maintenance.

(summary of additional response provided by Bill Schrock at Public Meeting) [Stormdrain cleaning] has been a recognized maintenance practice in the past and was apparently simply deferred for budgetary reasons.

(summary of additional response provided by (b) (6) at Public Meeting) I don't think diligent cleaning of stormdrains in general came about until the invention of vacuum trucks and the jetting trucks. Up until then it tended to be a pretty hit or miss affair in areas where I have lived. Since the jetting trucks were invented municipalities have been vigorously cleaning out the drains.

Subsequent Response: Stormdrain cleaning is needed because little or no routine cleaning and maintenance of these facilities was performed at the Bremerton Complex until recently. Considering the amount of deferred maintenance throughout the Complex, it is not likely that the stormdrains at OU NSC will be cleaned out as part of the overall maintenance program for a number of years. Following the initial cleaning, which will be performed under this CERCLA action, ongoing maintenance of the OU NSC stormdrains will be performed based on a specific plan and schedule to be developed during the remedial action.

5. Comment: (summary of oral comment made by (b) (6) at Public Meeting) How much of the cost of Alternative 3 is connected with the stormdrain cleaning?

Response: (summary of response provided by Paul Johanson at Public Meeting)(In round numbers stormdrain cleaning amounts to] approximately half of the cost of the third alternative.

Subsequent Response: After adjusting costs to reflect elimination of seal coating, stormdrain cleaning represents approximately 65 percent of the total cost of the selected remedy. A formal plan and schedule will be developed to guide stormdrain maintenance after the initial cleaning is performed.

6. Comment: (summary of oral comment made by (b) (6) at Public Meeting) Has any kind of study been done running a TV camera through these drains to see if they are intact anymore or if they have to be dug up and replaced?

Response: (summary of response provided by Paul Johanson at Public Meeting) We haven't talked a lot about the details of the stormdrain cleaning. Videotaping would very likely be included in the operation, if not for all of the lines at least in planning and designing the cleaning. It is certainly important to know whether there are breaks in the lines. You can't really do the work very effectively unless you have a sense of what you're getting into when you stick a hose or vacuum into a stormdrain line.

Subsequent Response: Details of the stormdrain cleaning process will be established during the remedial design process and described in a set of work plans prepared to guide the work. Damaged stormdrain lines are a concern since breaks in the lines could allow groundwater or soil/fill to enter the stormdrain system.

7. Comment: (summary of oral comment made by (b) (6) at Public Meeting) If we don't have the materials quantified and we're basing an assumption of what's down there on pretty limited data, and the removal and the cleaning of those stormdrains is half the amount, then that in my mind is not supportable. And [it sounds like we could] end up spending $3.5 million more dollars once you get down there and find out what's there. I think that needs to be considered before approving this plan as well.

Response: (summary of response provided by (b) (6) at Public Meeting) Extrapolating from [limited] data to prepare an estimate is legitimate. There has to be a starting point. These estimates are subject to review and revision. That's part of my background and I have done it for a number of years.

(summary of additional response provided by Barry Rogowski at Public Meeting) Anna is right that there is a range of possible costs and these estimates are not exact.

(summary of additional response provided by Bill Schrock at Public Meeting) The feasibility study certainly gives definite numbers for the cost estimates, but the numbers are prefaced with a statement that the actual costs can be as much as 50 percent higher or 30 percent lower than the estimate. We think we're in a reasonable range given what we know right now.

Subsequent Response: The Navy acknowledges that there is uncertainty associated with the potential cost of the selected remedy. It should also be noted that while the operation and maintenance costs included in the estimate cover 5 years of operation it may be necessary to provide maintenance for more than 5 years.

8. Comment: (summary of oral comment made by (b) (6) at Public Meeting) Paul, did you say that the Shipyard or somebody had decided to do all petroleum cleanup at once or something like that, what did you say?

Response: (summary of response provided by Paul Johanson at Public Meeting) What was describing was a program that EFA is embarking on. I don't believe the details have been worked out yet, but the intent is that petroleum contamination at the shipyard and other Navy sites in the Northwest will all be considered together. Petroleum contamination is common enough that it can't all be addressed at once. The goal is to try and prioritize the problem areas. We'd like to avoid the situation where a costly petroleum cleanup is started at OU NSC because the site happens to have been studied first. The oil here appears to be contained behind the quay wall, and there may be similar situations elsewhere where there is no quay wall that should be cleaned up first. It seems like a high priority should probably be assigned to sites that pose the biggest threats to the marine environment.

(summary of additional response provided by Bill Schrock at Public Meeting) Our office [EFA NW] is the holder of the budget for (petroleum cleanup as well as the RI/FS process]. The word from Washington DC is that petroleum sites are considered "low risk" sites and they only want to fund cleanup of maybe 10 percent of the low-risk sites each year. So our office is working on putting together a comprehensive plan for all the petroleum problems at all the sites we work on and try to prioritize these.

(summary of additional response provided by Patty McGrath at Public Meeting) Another reason for not including petroleum cleanup in the proposed plan is that the conditions do not seem to involve just a single area with a known source. We were afraid that, not knowing for certain what sources were involved, if we cleaned it up the area could just get recontaminated. Hopefully by looking at all petroleum sites together there is a greater chance of understanding the potential sources.

Subsequent Response: The Navy considers sites contaminated with petroleum to be a comparatively low priority compared to sites contaminated with more toxic materials. The Navy tentatively plans to budget for cleanup of only 10 percent of the TPH sites each year, with highest priority likely assigned to sites that appear to present the greatest environmental threat.

9. Comment: (summary of oral comment made by (b) (6) at Public Meeting) I thought it was the oil pipeline that had leaked beneath the wells where hydrocarbons were found.

Response: (summary of response provided by Patty McGrath at Public Meeting) I think the pipeline was tested and found to be okay.

(summary of additional response provided by Paul Johanson at Public Meeting) The pipeline was tested in the last year and found to be tight. That doesn't mean it couldn't have leaked in the past, and these are the main oil supply lines that run right through the middle of OU NSC. The pipelines and associated pumping and storage facilities have to be suspected as potential sources of petroleum. However, as Patty said, there's a risk that the Navy could undertake an expensive soil cleanup in this area and later find the soils recontaminated. It's hard to consider that a prudent use of funds.

Subsequent Response: Although the oil pipelines and associated facilities and the Building 588 oil separator facility seem likely sources of the petroleum contamination observed at OU NSC, the contaminant sources have not been definitively established. Additional potential TPH sources may be identified during the OU B investigation.

10. Comment: (summary of oral comment made by (b) (6) at Public Meeting) When petroleum hydrocarbons and TPH infiltrate into the soil they tend to change over time. If, during the [process of prioritizing the Navy's petroleum sites for cleanup], it is determined that we have other risks because of those changes, could those sites be upgraded because they have become more dangerous?

Response: (summary of response provided by Bill Schrock at Public Meeting) Yes. If, for example, there was a lot of benzene, that would certainly drive the risk higher. So if there are constituents within the petroleum that make a site high-risk, we can address that earlier than normal TPH sites with heating oil or something like that.

Subsequent Response: Although benzene can be produced as a result of breakdown of some petroleum materials, benzene was not identified as a chemical of concern at OU NSC.

11. Comment: (written comment submitted by (b) (6) at Public Meeting) I really think you should use

part of alternative four as a test of this technique. The Navy sites have a lot of petroleum-contaminated areas and we need to know if the air-blowing technique works. You've got a couple of spots at OU NSC that would be good spots to try this technique and if it does work like it sounds it will, you'll have less contamination to deal with later. It's a low-tech, inexpensive, permanent fix and you should try it here (although maybe not at all your sites).

Response: The Navy is in the process of compiling a list of sites with petroleum contamination throughout the Northwest in order to prioritize cleanup. In situ air injection, as included in Alternative 4, will likely receive consideration for treating petroleum contamination of soil.

Subsequent Response: The effectiveness of bioventing would likely be limited at OU NSC given the heterogeneous nature of the fill and the existence of floating product on the groundwater. Treatability studies would be essential to establish whether this approach is feasible at the site. The Navy is currently conducting a steam sparging project in petroleum-contaminated soil in the OU C area north of OU NSC.